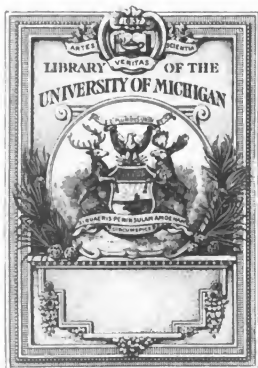


**CHEMICAL
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IN ALL ITS APPLICATIONS TO

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THE CHEMICAL NEWS.

VOLUME XLV.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1154.—JANUARY 6, 1882.

ON GROVE'S, PLANTÉ'S, AND FAURE'S SECONDARY BATTERIES.*

By Prof. W. GRYLLS ADAMS, M.A., F.R.S., &c.

THE effects on which the action of secondary batteries depends have long been known, in fact the history of secondary batteries is almost as ancient as the history of Voltaic Electricity. It might even be said that the history of secondary batteries is older than the history of voltaic batteries, for in 1795 Galvani noticed that when shocks from an electric eel were given to the nerves of a frog, it was possible to obtain an electric shock by holding the leg of the frog in one hand and touching the nerves with the other. In a note-book of Galvani's which was exhibited at the Electrical Exhibition in Paris, 1881, Galvani gives an account of these experiments, and supposes "that the electric eel had transmitted a part of its electricity to the frog, which was capable of holding the charge and giving it out again," and he even supposes that after being discharged it might again receive a charge, and might give it out again when required. In the year 1800 Volta discovered his battery or pile, which gave the method of producing electric currents through the agency of chemical actions, and in the year 1801 Gautherot, a scientific Frenchman, observed that when wires of silver or wires of platinum were used for the decomposition of the acidulated water, the two wires gave a current of electricity after they were detached from the battery. This was termed the polarisation current, and the effect was said to be due to polarisation; a convenient term introduced to express something, the meaning of which was not understood.

Only two years later, in 1803, Ritter, of Jena, observed a similar effect when using gold wires for the decomposition of water, and it occurred to him to devise a battery for producing and making use of these secondary currents. He made use of various metals, and succeeded in getting strong effects with platinum and with silver wires; he also succeeded in getting currents of electricity with iron wires, with brass, and also with bismuth, using water slightly diluted with acid for his liquid. It also occurred to him to make use of lead, but with this metal he did not succeed in getting a current, because with it he used a solution of chloride of lead, which is a non-conductor, or offered too high a resistance to produce any effect which could be ob-

served. Thus within three years of the discovery of Voltaic Electricity Ritter had discovered and made use of secondary batteries. He charged fifty cells of a secondary battery by means of 100 couples of Volta's pile, and produced different chemical and physiological effects, such as were produced by the original battery. This secondary action was attributed to an absorption, or soaking in, of the two opposite kinds of electricity by the metals, and the current obtained was called a polarisation current. The investigations of Volta and Mariani gave clearer ideas with regard to this secondary action, and after them Becquerel, by his investigations on batteries with platinum plates and two different liquids, showed that in the secondary batteries the liquids immediately surrounding the two plates were no longer in the same state, but that there were present all the elements which were required to produce a voltaic battery, i.e., two different substances united by a liquid conductor in which chemical action could take place. Different theories were started to account for the action.

In the year 1805, Grotthuss, writing on the decomposition of liquids by voltaic electricity, regarded the poles as attracting the two opposite kinds of electricity. The pole from which resinous electricity issues attracts hydrogen and repels oxygen, whilst the pole from which positive electricity issues attracts oxygen and repels hydrogen. In 1806 Sir Humphry Davy also supposes the decomposition and giving off of gas to be due to the attractions of the poles, and that the decomposition and recombination go on throughout the fluid from one particle to another of the fluid, the gases or decomposed bodies only appearing separate at the poles.

In 1825 De la Rive explained the action as being due to an affinity or combination of the elements with the electric currents. The current from the positive pole combining with the hydrogen or the bases it finds there, leaves the oxygen or the acids at liberty, but carries the substances it is united with across to the negative pole, where it enters the metal conductor and leaves the hydrogen or base on the surface. In the same way the electricity from the negative pole sets the hydrogen or base which it finds there free, but unites with the oxygen or acid and carries them across to the positive pole, and there leaves them.

De la Rive does not admit that there is successive decomposition and recombination going on in the course of the electric currents throughout the liquid, but regards the decomposition as only taking place at the poles.

Thus far had opinions advanced when Faraday attacked the subject, in 1833, and set the whole theory of electrica

* A Paper read before the Science Society of King's College, London, Tuesday, October 23, 1881.

decomposition on a firm basis in his four series of papers communicated to the Royal Society between June, 1833, and March, 1834. I have not time for more than a passing allusion to the laws of electrolysis which he established, and to his opinions on the relation of electricity to chemical action, which are now well known. How he established that the sum of chemical decomposition is constant for any section taken across a decomposing conductor. That for a constant quantity of electricity the amount of electrochemical action is also a constant quantity, whatever the decomposing conductor may be, whether water, salt solutions, acids, fused bodies, &c.; the quantities of substances decomposed by the same current being in proportion to their mutual chemical affinities; and how he concluded that "the forces termed chemical affinity and electricity are one and the same. That the evolved substances appear only at the poles, because everywhere else each particle finds other particles having a contrary tendency with which it can combine."

Thus Faraday traces the decomposition to the action or modification of the internal forces in the molecules decomposed rather than to external forces like the attractions of the poles upon them. The poles are merely the doors by which the electricity enters or leaves the electrolyte and metals, and even gases may be used as poles.

In this series of experiments he devised his volta-electrometer or voltmeter, with which he fully established the law that "The chemical power of a current of electricity is in direct proportion to the absolute quantity of electricity which passes."

In explaining the action which he regards as going on in the battery, he says—"I suppose that the effects are due to a modification by the electric current of the chemical affinity of the particles through which or by which that current is passing, giving them the power of acting more forcibly in one direction than in another, making them travel by a series of successive decompositions and recompositions in opposite directions, and finally causing their expulsion from the mass of liquid when they reach the poles." In this series of papers he very powerfully sums up his reasoning as to the identity of voltaic electricity and the electricity of the machine. He says:—"One grain of water, acidulated to facilitate conduction, will require an electric current to be continued for three minutes and three-quarters to effect its decomposition, which current must be powerful enough to retain a platinum wire $\frac{1}{16}$ th of an inch in thickness red-hot in the air during the whole time; and if interrupted anywhere by charcoal points, will produce a very brilliant and constant star of light, and the beautiful experiments of Wheatstone have shown that this quantity of electricity is equal to a very powerful flash of lightning; yet we have it under perfect command, and when it has performed its full work of electrolysis it has only separated the elements of a single grain of water.

In the same paper he clearly states the laws of the transformation of energy, and enunciates the important principle of the Conservation of Energy, which now forms the bond between the various physical sciences.

He says:—"Considering the twofold relation that without decomposition transmission of electricity does not occur, and that for a definite quantity of electricity a definite quantity of electricity is decomposed, it seems a natural consequence that the quantity passed is the equivalent of the chemical affinity of the particles separated; i.e., that if the electrical power which holds the elements of a grain of water in combination, or which makes a grain of oxygen and hydrogen in the right proportions unite into water, could be thrown into the condition of a current, it would exactly equal the current required for the separation of that grain of water into its elements again."

Among the causes of the diminution in force of the voltaic battery Faraday includes what he calls the peculiar state acquired by the metal surfaces in the second vessel (i.e., the negative pole), which caused them to oppose the passing current by the force of a secondary current. Hence

he draws practical conclusions, that weak and exhausted cells should never be used with strong and fresh ones. Thus fifty cells, with ten of them not charged equally to the rest, gave nine-tenths of a cubic inch of gases in half a minute, whereas the forty good cells gave 41 cubic inches in the same time.

In the course of his experiments on this subject Faraday frequently found apparent contradictions to his simple law of electrolysis, but he was led to refer all deviations from it to the action of secondary currents; as, for instance, in the evolution of nitrogen at the positive, and hydrogen at the negative, pole in a voltmeter containing sulphate of ammonia dissolved in a strong solution of ammonia. The hydrogen as measured by a voltmeter was obtained from the decomposed water, whilst the nitrogen was a secondary result depending upon the chemical action of oxygen at the positive pole.

He may almost be said to have discovered a secondary battery similar to that of M. Planté or M. Faure, when using acetate of lead for his solution he finds that the results at both electrodes are secondary; peroxide of lead appearing at the positive, and lead itself at the negative pole.

Whether, as was at first supposed, under the influence of the primary current, the metal electrodes acquired a sort of static charge, positive on one and negative on the other, thus producing a polarisation current, or whether the whole of the secondary current might be regarded as due to the deposition and absorption of gases decomposed from the liquid, so altering the surfaces of the electrodes, and therefore converting a voltmeter into a battery cell, might still be regarded as an unsettled question. In 1843 Grove gave an important contribution towards its solution when he invented his gas battery, in which two platinum plates were immersed, one in oxygen and the other in hydrogen, thus forming a secondary battery which could be employed for the storing up of electrical energy. Grove's gas battery may be said to be a voltmeter in which the platinum plates extend throughout the height of the tubes for collecting the gases of the voltmeter, and are attached to platinum wires sealed into the glass at the top of the tubes. After a current from a battery has passed through the voltmeter it is detached from the battery, and the two platinum wires of the voltmeter are at different potential and give a secondary current when they are brought in contact or attached to a galvanometer. This current, as in all cases of secondary currents, is in the opposite direction in the cell to the battery current which produced the decomposition. This may be readily seen on charging the Grove's gas battery and then testing the difference of potential of its poles by means of a quadrant electrometer, by which means we may compare it with a standard battery and determine its electromotive force. We may also unite the poles to a galvanometer with a resistance or shunt to take off the greater part of the current, and so may measure the current which this battery will send through a known resistance.

In 1852 Dr. C. W. Siemens constructed a secondary battery on the plan of Grove, with carbon plates for his poles in place of platinum, and in order to increase the effects he inserted the carbons in a strong solution of acetate of lead, so that, on passing the battery current through the cell, peroxide of lead was deposited on one of the poles, and the secondary battery was formed. The electromotive force of this battery was such that one cell of it was sufficient to produce the decomposition of water. Hence the electromotive force must have been nearly equal to two volts. The volt is the unit of electromotive force which has for some time been in use in England, but which has only quite recently, at the Paris Congress of Electricians, been generally received throughout the whole of Europe. Its value is very nearly the same as the electromotive force of one Daniell's cell, so that we may conveniently make use of a Daniell's cell for our standard of comparison for electromotive forces.

In order to find what current a battery of given electro-

motive force will send through a given resistance in a unit of time, we may make use of Ohm's law that $C = \frac{E}{R+r}$ —or, as we may put it, $E = C(R+r)$. The resistance ($R+r$) is expressed in ohms, which has long been the English unit of resistance, but which has only now, viz., at the Paris Congress, been accepted by Europe as the unit of resistance.

The equation $E = C(R+r)$ requires that if the electromotive force is one volt and the resistance of the circuit is one ohm, then the current must be equal to one unit of current; if $E = 1$ and $R+r = 1$, then $C = 1$, i. e., the unit of current is the current which a volt will send per second through an ohm. The name lately given to this current in England was the Weber; but since the Germans have been accustomed to use the Weber in a different sense, it has been thought better at the Paris Congress to drop the name of Weber for the unit of current, and France and Germany, and other countries, have agreed by their representatives at the Congress, and with the consent of the practical men present at the International Exhibition, to call the union of current an *Ampère*—so that what we have been accustomed to call a *Watt* has now been called an *Ampère*, and is the current which an electromotive force of one volt sends per second through a resistance of one ohm.

For the sake of uniformity and to prevent confusion the German scientific men and practical electricians have agreed to accept the English ohm as their unit of resistance, and to give up the mercury unit, or metre of mercury, which they have always been accustomed to employ. Into the relations of these units to what are called the C. G. S. system of units, I will not now enter. Now that we come to the storing up of electrical energy in secondary batteries there is the necessity for another unit, viz., the unit of quantity stored up in a battery without regard to time. For the current flowing in a circuit is the quantity of electricity per second. We cannot define the current which a secondary battery can give without giving the resistance of the circuit, but we can state that a given secondary battery will be of a certain electromotive force, and will store up a certain quantity of electricity ready for use when required.

The name which has been accepted at Paris for the unit of quantity is the *Coulomb*, so that, according to the latest acceptance, the amount of energy stored up in a secondary battery may be expressed in *Volt-Coulombs*.

We may store up electrical energy of very high potential in a Leyden jar or condenser, and make use of it at intervals instead of taking it continuously from an electrical machine. We cannot raise the potential of the charge in a Leyden jar any higher than the potential of the machine from which it is charged. We may as well expect heat to flow from a cold body to a hot one and make it hotter, or think that we can get water of its own accord to flow up a hill into a reservoir at the top. In connection with this question of storage of energy I may help us to trace the analogy between difference of potential with regard to electricity and difference of level with regard to the force of gravity.

The difference of potential giving rise to electromotive forces between two points which are united by a conductor causes a current of electricity from a point of higher to a point of lower potential, just as a difference of level giving rise to pressure between two points in a water channel causes a flow of water from the higher to the lower level. The electromotive force corresponds to pressure, and the resistance of the circuit corresponds to the hindrances to the flow, the current corresponds to the quantity of water flowing per unit of time. Thus of two paths from one level to another, the current will be most rapid along the steepest channel, and in the same way with the same electromotive force, the greatest current will be along the line of least resistance.

The electricity supplied by the electrical machine will be like a very small stream supplied by a pump at a very

great height, and discharging itself by a small pipe at a very much lower level, so that it is capable of exerting very great pressure, but when allowed to run it can do very little work, because the quantity is small.

The Leyden jar is like the reservoir into which the water is pumped at a high level, and when the size of this reservoir is increased we know how difficult it is to prevent leakage from the very great pressure exerted by the water, and how dangerous the bursting and discharge from such a reservoir may be to those on the lower level who may happen to be on the path of the discharge.

On the other hand, the ordinary Grove's battery giving us electricity in abundant quantity, but of small difference of potential, is like a means of obtaining, when required, an ample supply of water, as from a large reservoir not far above the level where it is wanted to be used, and so giving an abundant supply at low pressure. Had this mode of supplying electricity continued to be the principal one, we should probably not have so much need, and should not hear so much, of secondary batteries; for instead of burning up the zinc in the Grove's battery to charge up the secondary battery, like a large reservoir, to-day, in order that the stored-up electricity may be used to-morrow, it would probably be better not to charge the Grove's battery until to-morrow, and then use it directly to do the work required.

The development of Faraday's discovery that the motion of a coil of wire in front of the poles of a magnet, or in a magnetic field, gives rise to an electric current in the wire, has shown us that the burning of zinc or other materials in batteries such as Grove's or Daniell's is a very expensive way of producing an electric current, and that it is far more economical to obtain electric currents by employing the best mechanical means we have to produce rotation of the coil of wire in the magnetic field. The different magnets and dynamo-electric machines (and they abound) are but the results of attempts to find the best form of coil, the best kind and best form of magnets, the best proportion of resistances, and the most suitable arrangements for the special work in each case which is required to be done.

The dynamo-electric machine driven by a steam-engine, or by a gas-engine, is very satisfactory as a mode of producing electricity, and both the electromotive force and the current increase with the rate of rotation of the coil.

This mode of producing electricity is like raising water to any level that may be required in each particular case, but the electricity must be used at once whilst the steam-engine or the gas-engine is in action. This may be very inconvenient, and hence the necessity for something like a reservoir to store up the electricity.

The labours of Faraday have shown us the relation between the quantity of electricity and the weights of the chemical elements decomposed by it in an electrolyte, and that these chemical elements may unite again to reproduce the same quantity of electricity. The object, then, to attain by means of secondary batteries, is to find some substance which can be decomposed into two others which will remain apart, even when joined by a liquid conductor, until a complete electric circuit is made; then these two substances should be at considerable difference of potential, so as to give a strong electric current in uniting again to form the substance from which they were decomposed.

In 1859 M. Planté, taking advantage of the great affinity of peroxide of lead for hydrogen, made use of this substance to increase the effects of secondary batteries, and so was led to make use of lead electrodes instead of platinum, which had been the metal hitherto employed. He found that better results could be obtained with one cell with lead electrodes than with twenty cells with platinum electrodes.

To form this battery, plates of lead with a finely divided layer of lead upon them are taken as electrodes, a current from two Grove's cells is sent through the cell containing them, immersed in diluted sulphuric acid of strength about

one to ten; the current is sent for a quarter of an hour in one direction, then the cell is fully discharged; the current from the primary battery is then sent through it for a quarter of an hour in the opposite direction, after which the cell is again discharged: in this way it is charged over and over again in opposite directions for longer and longer periods, care being taken each time that the secondary cell is fully discharged. Then the battery is again charged; but when it is capable of giving out the charge slowly enough for the purpose for which it is to be used, then the successive chargings should no longer be given in opposite directions, but always in the same direction. We may say that after the battery is formed it should always be charged in the same direction.

In charging by sending a primary current through the cell, peroxide of lead is formed at the positive pole, and the negative pole becomes somewhat crystallised. When detached, the peroxide of lead forms the positive pole of the secondary battery, and the battery will remain in action until the two plates return to the same state, the positive pole being reduced from the peroxide to the oxide of lead, and the negative pole being transformed from lead to the oxide of lead.

M. Planté has especially aimed, by means of his battery, to convert electricity obtained from an ordinary battery into electricity of high tension, to do in a smaller degree what is done by means of the Ruhmkorff induction coil. By means of two cells of Grove or Bunsen he can charge a great number of cells, a dozen or more, arranged for quantity, *i.e.*, with all their positive poles together and all their negative poles together, and when they are charged by arranging them in series—*i.e.*, with the positive pole of one joined to the negative pole of the next—he can get great electromotive force, and at the same time obtain electricity, in great quantity.

By his battery of 800 cells, which he has set up in Paris, and by the aid of his rheostatic machine, which I have not time to describe, he can imitate lightning discharges and remarkable luminous effects, somewhat analogous to the brilliant effects of the Aurora Borealis.

The electromotive force of a single cell of Planté's battery is about 2½ volts, or 2½ times that of a Daniell's cell, *i.e.*, about 1½ times Grove's cell; hence two cells of Grove will charge a Planté cell. The quantity of electricity that may be collected will depend on the amount of chemical action, *i.e.*, on the extent of the surface of the plates, and on the way in which that action has gone on. When the action has gone on rapidly, the battery will not be so good as when the action is slow. The Planté battery, as usually formed, discharges itself too rapidly for many purposes for which electric accumulators are now required, and hence other secondary batteries or modifications of the Planté battery are now making their appearance. The cells may be charged by a dynamo machine, and may also be used to drive a dynamo machine, like an electro-magnetic engine or motor, driving it in the same direction as when it was driven when used as a generator to charge the cells. On attaching the wires from a Planté cell to a small dynamo machine, this machine is converted into a motor and may be employed to work a pump or to do other useful work.

The Planté cell will also heat a platinum wire of considerable diameter, for although the electromotive force is only 2½ volts, yet the quantity is sufficient to make a platinum wire three-tenths m.m. in diameter, and 4 c.m. in length, to glow for half an hour.

The secondary battery may be made use of in telegraphy, to do away with the residual magnetism in an electro-magnet, so as to enable it to work more quickly after a current has been sent through it. The secondary cell should be attached with its positive pole to the line and its negative pole to the key, the other end of the line or the earth being also attached to the key so as to form a complete circuit when the key is up; the sending battery, consisting of two or more cells of Grove, or at least three Daniell's cells, should have its negative pole attached to

the negative pole of the secondary cell, and its positive pole to the key, so as to form a complete circuit with the line and secondary cell when the key is down. When contact is made with the sending battery by putting down the signalling key, the current is sent through the secondary cell into the line, thus giving a slight additional charge to the secondary cell and bringing the electro-magnet into action; on breaking contact by releasing the key, the secondary cell, being still connected to the line, sends a reverse current into the line, and weakens, or may even be strong enough to reverse the magnetism of the electro-magnet. If we work a Morse instrument first with the sending battery alone, and afterwards with the secondary cell in the circuit, we find that there is a very great increase in the rate of signalling when the secondary cell is used. The secondary current increases as the battery current increases, and being in the reverse direction, instantly weakens the magnetism of the electro-magnet, so that signals may be sent as fast as the operator can make and break contact.

Another application which M. Planté has made of secondary batteries is for engraving on glass. The glass plate is placed in a shallow dish and covered with a thin layer of a strong solution of nitrate of potash, one platinum wire from the positive pole of the battery is placed in the solution along the edge of the glass plate, and the other platinum wire from the negative pole, sealed in a glass tube for a handle, is used as a pen to trace the form of the required engraving. With slow writing the engraving is deep, and the breadth of the stroke depends upon the diameter of the end of the wire.

The Planté secondary battery has been employed to work an electric break on railway trains. With two Grove's cells or three Daniell's cells, and a Planté cell arranged as above described, the Planté cell is continually being charged, or is kept from getting weaker except when the key is depressed, which completes the electric circuit by which the break is set in action.

The quantity of electricity stored up in six Planté cells, is sufficient, with such an arrangement to prevent the cells from becoming exhausted, to work the brakes on a dozen railway carriages, and to last for a fortnight. To renew the charge in the Planté cells, a battery of six Daniell's cells may conveniently be employed. It is important that the charging should be carried on with great regularity, so that the layer of peroxide of lead may be regularly laid on, otherwise it will not adhere well to the lead electrodes.

Several forms of secondary batteries have appeared quite recently, now that the demand has arisen for a reservoir in which to store up the electricity produced by the dynamo-electric machine, and the secondary action or polarisation of batteries is no longer regarded as something to be avoided as much as possible, but is eagerly sought after. Professors Houston and E. Thomson, of Philadelphia, have tried electrodes of copper in sulphate of zinc. When a current is sent through the cell, zinc is deposited on the negative pole, and sulphate of copper formed around the positive pole, the plates being laid horizontally so that the sulphate of copper so formed and the sulphate of zinc shall be prevented by their relative weights from mixing too readily. This we may call a gravity secondary battery, and its electromotive force will be nearly the same as that of one of Daniell's cell or one volt. M. d'Arsonval modifies this battery by using an electrode of lead and another of zinc in a solution of sulphate of zinc, the lead forming the positive electrode becomes coated as in the Planté cell with peroxide of lead.

Several modifications of Planté's cell have been suggested, which have for their object the reduction of the weight of lead employed; such are the batteries of M. de Pezzer and of M. de Meritens, who fold their laminæ of lead in layers like the leaves of a book, so as to get as much surface as possible for a given weight of lead. M. de Pezzer also finds that the relative size of the positive and negative plates modifies the results obtained, a greater

quantity of electricity is stored up when the negative electrode is double the size of the positive electrode than when the two electrodes are of the same size.

Other modifications, in which the negative pole is either palladium in dilute sulphuric acid, or thin sheet iron in a solution of sulphate of ammonia, have been suggested and employed by M. Rouse, these substances being chosen on account of their great power of absorption of hydrogen. These can hardly be called secondary batteries, since two metals are employed in them as electrodes. The method of charging secondary batteries may sometimes be conveniently made use of to renew ordinary batteries which have become used up. Thus a Leclanché cell which has been in use for a long time and become weak, may be recharged again by connecting up the positive pole of a stronger battery with the positive pole of the Leclanché battery and allowing the current to pass through it for a considerable time. In the same way a dry pile, which has become weak, may have the difference of potential of its two ends increased by sending a current through it from its positive pole to its negative pole; i.e., the positive pole of the battery should be joined to the positive pole of the dry pile. The secondary battery, with which most attention has been drawn during the last few months, is the Faure battery, in which M. Faure does not form the cells by electrolysis, but coats the lead plates with a film of red lead or minium, enclosing or protecting the red lead coating with a layer of felt. His cells are of large size, and each is therefore capable of storing up a considerable quantity of electrical energy. The chemical action is similar to the action in a Planté cell, but the resistance is higher, and when in use the battery takes longer to discharge itself, so that for electric lighting and for many purposes for which a store of electricity is required, it seems to be better adapted than the Planté cell.

It has been said, and the statement has been confirmed by Sir Wm. Thomson, that a "Faure accumulator, weighing 75 kilograms (165 lbs.), can store and give out again energy to the extent of an hour's work of one horse-power," or two million foot-pounds. At first these cells were made cylindrical, and the Faure Accumulator Company have kindly lent me a box of four such cells in action, similar to the celebrated box of electrical energy, or condensed lightning, so graphically described in the *Times* of May 16th last, which was carried from Paris to Glasgow for examination and measurement by Sir Wm. Thomson. They have also lent me one of their latest forms, in which the plates are flat and placed vertically in the box.

It has been ascertained by Sir Wm. Thomson that Faure's accumulators, amounting in weight to three-quarters of a ton, will continue to work for six hours from one charge, at the uniform rate of one horse-power, and that probably go per cent of the energy spent in charging will be transformed into useful work. Very few comparative trials have been made of the Planté and the Faure batteries, but from those which have been made by M. Achard, it appears that, as might be expected, they are equal in electromotive force, that the Planté cell is of smaller resistance than the Faure cell, and consequently will heat a longer piece of platinum wire and do its work three times as rapidly. The Planté cell kept a platinum wire three-tenths m.m. in diameter, and five or six c.m. long, red hot for an hour, and the Faure cell kept the same wire red hot for an hour and a half. We may readily see by a few experiments that the Faure's battery has collected a great quantity of electrical energy, for one box of it will cause a platinum wire of considerable length, and one m.m. in diameter, to glow, and one cell is sufficient to drive a small dynamo-electric machine as a motor, or to drive a small electric engine, and the three or four cells are sufficient to cause a small Swan's incandescent lamp of small resistance to give out a very pleasant light of about two candles. Those who saw my lecture room and the Wheatstone laboratory at our Jubilee Soirée on July 2nd last, brilliantly lighted during the evening by Swan and Lane Fox incandescent lamps, which were kept in

action by means of Faure's accumulators, will not doubt the possibility of lighting by means of incandescent lamps, nor forget the satisfactory results obtained through the agency of Faure's secondary battery.

There are many applications which have been or may be made of secondary batteries. Six Planté cells have been found sufficient to drive a tricycle with 160 kilograms, or about 350 lbs., upon it, at a rate of ten miles an hour, or to drive a boat containing three persons.

These secondary batteries (1) may be used to carry a supply of electricity where it is wanted. (2) They may accumulate supplies from a dynamo machine and store energy up for electric lighting or for motive power. (3) They may serve as regulators for the electric current, when as in electric lighting it is liable to fluctuations, either from the irregularity of the driving engine or from the change of resistance in the electric arc or in the electric current. When so used, they would supply and keep up the light even though the engine were suddenly to stop, or any accident to happen, other than the cutting of the connecting wires. The Faure's accumulator has been employed to light a railway train from London to Brighton, by means of incandescent lamps, and to work an electric motor so as to drive a circular saw or other mechanical tools. It has also been employed with very satisfactory results in driving a tramway in the streets of Paris, and in the Siemens Electric Railway between the Electrical Exhibition and the Place de la Concorde. The results already attained seem to show that there is no other secondary battery which can compare with this for storing up and keeping for a long time a supply of electric energy, and for using it slowly when in action.

ELECTRIC LIGHTING—ITS FIRE RISKS AND THEIR REMEDIES.

By HENRY MORTON, Ph.D.,
President of the Stevens Institute of Technology.
(Continued from vol. xlv., page 288).

As a means of practically dealing with the above subject it will be perhaps best, in the next place, to review the "requirements" recently recommended to the New York Board of Fire Underwriters by their Committee on Origin of Fires.

The first of these requirements is that all wires used to convey electric currents for lighting purposes should have at least fifty per cent more conductivity than is requisite for the number of lights to be supplied by such wires.

This requirement is a perfectly fair one and in accordance with the general principles set forth in my previous article, but its signification is rather obscure and indefinite; it is also one which is certain to be fulfilled by all those who are engaged in supplying electric light, on economic grounds.

The term "conductivity necessary for the supply of the number of lights used" is, in the first place, obscure, because, in the case of arc lights, run as they always are in successive series, the conductivity necessary for one or for any number of lights is the same. A wire which will carry a current to one arc light will continue to carry it on from this light to the next, and so on to any extent, just as a road which is wide enough to let one cart pass is wide enough for a train of carts, passing one after the other. We may, in fact, regard the successive arcs as like a series of cascades on the same stream, down which the same water runs from one to the other, and where manifestly no more is required to supply the whole series than to supply any one of the successive falls.

This consideration, therefore, manifestly contemplates only incandescent lights where the number of lights will determine the quantity of the current needed to supply them, because they are always connected in parallel series,

and the portion of the current which traverses one lamp traverses no other, but returns to the generating machine by the conductor.

In this connection another point should be noticed. In the machines used for producing arc lights the armatures of the machines are wound with a wire very much smaller than that which it is economical to use in any other part of the circuit. If, therefore, a current was produced sufficient to develop heat in the circuit, it would develop much more in these armature coils than anywhere else. In fact, in the ordinary running of such machines these coils become quite hot, even when no sensible heat whatever is developed in the line wires, and it is manifest that long before the line wires could become dangerously heated the wires of the armature would be melted and the machine destroyed. Nor is there any danger that these proportions will ever be changed by those using such apparatus. Every unit of heat produced in the conducting wires is a dead loss of power, and to have the conducting wires of a circuit so small that they would get as hot as boiling water even, would double or treble the cost of operating the system, or make it, in fact, not profitable, but ruinous to those interested.

Although, in the machines used for the incandescent light, the armature is often made of bars of copper, and would not be heated to destruction by a current which would heat the conductor to a dangerous degree; yet the question of economy is equally important in this case also, and those supplying such lights will be sure in their own interests to use conductors of abundant capacity.

The first requirement may then be regarded as one which, however defective in expression, is right in intention, and will be readily complied with by all those supplying or using electricity as a source of light.

The second requirement is that all conductors should be insulated and doubly coated with some approved material.

This requirement is also reasonable and fair in spirit, though faulty in expression.

Thus "a double coating," of course, means nothing as regards efficiency, since two thin coatings might be inefficient where one thick coating was thoroughly effective, and it is manifest that no one material should be exclusively selected. Any insulating material which is a good insulator and, at the same time, has such mechanical properties as will secure its maintaining its position on the wire under normal conditions of wear, or any combination of materials securing like results, would of course meet the actual requirements of the case. In applying this regulation, moreover, it must be remembered that the coating is not to be regarded as a sort of armour to keep in some explosive fluid which is endeavouring to escape, but is rather a "fender" to prevent contact of the wire with other conductors, and that no harm can come as long as such contact is prevented.

The third requirement is stated as follows:

"All wires are to be securely fastened by some approved non-conducting fastening, and are to be placed at least 24 inches from each other for incandescent lights and 8 inches apart for arc lights, and 8 inches from all other wires, and from all other metal or conducting substances, and to be placed in such a manner as to be thoroughly and easily inspected by surveyors."

These requirements literally construed would be impossible to fulfil in many cases, and in others would increase in place of diminishing the risks which they propose to obviate.

Thus, while, as a general rule, it is best to keep the outgoing and return wires as far apart as possible, this would manifestly be next to impossible where they approach the lamps, and, in such cases, would be utterly useless.

Thus, for example, the two wires twisted together as a cable, and inclosed in a strong metal tube, would be in the safest possible condition in many cases, as well as the most convenient where a cluster of lights or a single light was arranged in a chandelier, or the like fixture. Again, the wire being properly covered with an insulating

envelope would be much more secure if attached by strong metal fastenings than if held by insulating fastenings liable to break or yield.

Again, in an iron building it would be manifestly all but impossible to keep the wires 8 or even 24 inches from all metal or like conductors, and any such arrangement would be equally needless, if not, in fact, injurious.

The real security would be insured by so arranging the wires that all contact with the metallic or other conductors would be impossible, and then the insulated wire would be in its safest condition, if actually inclosed in the conducting substance out of reach and sight.

This third requirement will manifestly need radical modification before it can become effective in any way.

The fourth requirement is that all lamps should be protected by globes, so as to prevent the falling of sparks or particles of heated carbon or metal.

This requirement is obviously proper, and needs no comment.

I should here, however, remark that, in addition, some automatic device for throwing off the current if an excessive arc is formed, as mentioned in my previous article, would be necessary to make this requirement in all cases effective in securing its object, as otherwise so violent an action might take place that even the globe might fail to protect.

The fifth requirement calls for a means of shutting off the current from the outside, where wires enter a building from outside.

This is manifestly proper, just as it is in the case of an illuminating gas.

Another requirement which should be added is the insulation of the dynamo-electric machines from the ground. This would largely diminish the risks from contact with conductors and other wires, because two contacts with the electric circuit would then be necessary to secure the passage of the current through the accidental conductor. —*The Sanitary Engineer*, December 15, 1881.

NOTE ON A COMPOUND OF QUININE AND QUINIDINE.

By C. H. WOOD and E. L. BARRET.

THE discovery of a new alkaloid, closely resembling quinine, is that description of Cinchona bark known in commerce as "Cuprea bark," recently made by D. Howard and J. Hodgkin, and almost simultaneously announced by B. H. Paul and A. G. Cownley, and by W. G. Whiffen, will doubtless attract much attention. As these chemists all describe this newly discovered alkaloid as chiefly remarkable for its property of crystallising from an ethereal solution, it may be of interest to briefly refer to a peculiar crystalline body which we also first became acquainted with in working on samples of these Cuprea barks.

When Cuprea bark first came into the market, we noticed that an ethereal solution of the total alkaloids extracted from it would frequently furnish a notable quantity of crystals that did not resemble those of any of the known Cinchona alkaloids obtained under like circumstances. As the analysis of the total alkaloids, however, had not revealed the presence of any distinctive base, and as the Cupreas are chiefly remarkable for yielding an unusually large quantity of quinidine,* it seemed probable that these crystals were a compound of the quinine with the quinidine. We, therefore, took two grains of the pure quinine and one grain of the pure quinidine, both yielded by the bark, and dissolved them together in ether. The solution furnished an abundant crop of the same crystals. These crystals, when collected, washed with ether, and converted into neutral sulphate, furnished a quantity of

* We have met with several samples yielding over 1 per cent. of crystallised sulphate of quinidine.

pure sulphate of quinine, and the mother-liquor from which the sulphate had been separated yielded a like quantity of quinidine.

The quinine and quinidine used in the experiment had been carefully tested, they had each given the correct angle of rotation to a ray of polarised light, the one to the left and the other to the right, and the quinine had remained dissolved in ether for some weeks without furnishing a trace of crystallisation.

To satisfy ourselves that the power of forming this crystalline compound was not peculiar to the quinine and quinidine yielded by Cuprea barks, we took some pure quinine prepared by ourselves from South American yellow bark, and also some quinine made in India from the Calisaya grown in Sikkim. We fortunately possessed some pure quinidine that had been purchased from an eminent maker some time before Cuprea barks came into commerce. Either of these quinines dissolved with the quinidine in ether furnished a crystalline compound identical in all respects with that just described. There could be no doubt, therefore, that ordinary quinine and quinidine possess the power of combining together to form a crystalline compound very sparingly soluble in ether; also that the compound is easily separated into its constituents by converting it into neutral sulphate, when the quinine sulphate crystallises out by its greater insolubility, the quinidine sulphate remaining in solution.

Perhaps the easiest way of obtaining this compound is to dissolve one part of pure quinine in 30 or 40 of ether, and add to the liquid a saturated ethereal solution of a like quantity of pure quinidine. Upon mixing, a crystalline precipitate of the body forms in abundance. Its solubility in ether is much less than that of either of its constituents, 100 c.c. of ether at common temperatures only dissolving 0.5 grm. of it.

It is more soluble, however, in ethereal solutions of quinine or of the amorphous alkaloids, and these solutions frequently exhibit supersaturation very well, remaining clear for some hours and then suddenly giving an abundant crystallisation. The compound, when isolated, may be re-crystallised from ether, apparently without change. Our results up to the present moment indicate that it contains the quinine and quinidine in equal proportions. Pressure of other work had much retarded us in the study of this compound, and the announcement of the newly-discovered alkaloid by the chemists above-named took us somewhat by surprise. We at once commenced the examination of all the alkaloid products we have accumulated from several hundred samples of Cuprea bark in the hope of getting some of the new base, but as yet our attempts have been unsuccessful. We have thought it best, therefore, to publish our results thus far, and reserve further particulars for a future communication.

ON THE
ACTION OF WATER UPON LEAD PIPES,
BEING A
TRANSLATION FROM THE FRENCH OF M. BELGRAND,
WITH INTRODUCTORY REMARKS BY

W. SEDGWICK SAUNDERS, M.D., F.S.A.,
Medical Officer of Health and Public Analyst for the City of London,
Late President of the Hunterian Society, &c.

TO THE HONOURABLE THE COMMISSIONERS OF SEWERS
OF THE CITY OF LONDON.

GENTLEMEN.—Agreeably to the instructions of your Honourable Court, dated the 27th of September last, I present to you the following translation of the essay of M. Belgrand on the action of water on lead pipes.

In rendering the same into English I have endeavoured to convey the information it contains without strictly

adhering to the exact verbiage of the author, a course found necessary owing to the many technicalities with which it abounds, and for which I have been unable to find a literal equivalent; whilst it is, however, a perfectly free translation, the scientific details dealt with have been scrupulously reproduced.

The action of waters upon lead had been long recognised by chemists of all countries, and before the appearance of M. Belgrand's brochure much had been written upon the subject, and the chemical conclusions enunciated by him anticipated by a general consensus of scientific opinion.

The purest waters, when in contact with air, seem to produce the speediest effects, but no change is observable when lead is brought into relation with pure water from which the air has been expelled by boiling:—a powerful corrosive action goes on when the metal is exposed to the combined action of air and pure water. "The surface of the lead then becomes oxidised, the water dissolves the oxide, and this solution absorbs carbonic acid, when a film of hydrated carbonate of lead is deposited in silky scales. Another portion of oxide is formed, which is dissolved by the water, and thus a rapid corrosion of the metal ensues. This action is materially modified when various salts exist in the water, and even when their quantity does not exceed 3 or 4 grains in the gallon. The corrosion is increased by the presence of chlorides and nitrates, but diminished by sulphates, phosphates, and carbonates, the oxide of lead being scarcely soluble in water containing these salts in solution."—Prof. MILLER.

Water is said to have less effect upon lead when the metal is bright and new than when it has become tarnished by exposure to the atmosphere, but in either case the action is much more rapid with pure waters than with those containing foreign matters, salts, &c.

Many waters containing organic matter act upon lead, and it is probable that to this fact the well-known corrosive effect of alluvial deposits is due, when under these circumstances the metal becomes covered with a compact film of sub-oxide, which protects it from further injury.

Great divergence will be found in the writings of authors entitled to respect concerning the action on lead of waters containing free carbonic acid; thus, Miller, Graham, Frankland, Hofmann, and others, from whose works these introductory remarks are chiefly compiled, contend that carbonic acid protects the lead by forming with the lime salts existing in most waters an insoluble crust of carbonate of lead in the pipe, whereas M. Langlois* attributes a great action on lead to the carbonic acid, but admits that carbonate of lead counteracts its effects.

Prof. Parkes, however, reminds us that an excess of carbonic acid may dissolve this coating, since we know that water charged with this gas under pressure, as in aerated waters, will rapidly absorb lead, a fact which at once explains the occasional mischief produced by the incautious employment of leaden and composition pipes in the manufacture of artificial mineral waters and effervescing beverages.

Other substances in water, such as the organic acids of vegetables and fruit, and even sour milk, may have the same effect.

It has been authoritatively laid down, that "the presence of dissolved oxygen, and the absence of more than three volumes of carbonic acid in 100 volumes of water, are amongst the conditions necessary for the attack upon lead."—*Rivers Commission*, 1851.

Some waters contain lead as a natural constituent; the supply to the town of Edinburgh, for instance, is said to be contaminated to the extent of 1-10th of a grain to a gallon, a proportion which does not appear hurtful. Calvert found that from 1-10th to 3-10ths of a grain per gallon existed in some water at Manchester, and was the cause of much suffering. Again I may mention the well-known cases of poisoning amongst members of the Ex-royal Family of France, at Claremont, where 34 per cent

* M. Langlois, "Rec. de Mem. de Med. Mill.", 1865.

of those who drank the water were affected by 7-10ths of a grain per gallon. In my own practice I have invariably condemned water in which lead existed to the extent of 1-10th of a grain per gallon, and believe it would be safer to reject a sample containing even half this quantity, having regard to the fact that some persons are much more susceptible to its injurious effects than others.

In 1877, Mr. G. Bischoff called attention to the fact that lead piping frequently contains antimony, which adds sensibly to the danger of its use; the same chemist also adverts to the reprehensible practice of plumbers using composition tubing in connection with water supplies for domestic purposes.

In substitution for lead I know of nothing better than wrought-iron pipes leading from slate or galvanised iron cisterns, where a constant service cannot be obtained.

In H. M. Navy the water tanks are not galvanised, but the interiors are occasionally lime-washed, it having been found that with galvanised pipes the water becomes impregnated with zinc, which may be seen as a white film floating on the surface.

It is true that water in passing through iron pipes becomes turbid by the presence of yellowish suspended matter, which is in fact a hydrated oxide of iron or rust, but this is not injurious to health and is at once removed by ordinary filtration.

Hard waters act less upon iron than soft waters. The Sixth Report of the Rivers Pollution Commission, 1874, pp. 221-222, contains some very valuable information respecting the best methods of protecting cast-iron pipes from corrosion.

I object to the lining of one metal with another, such as tin upon lead, as proposed by M. Belgrand, for two reasons, first, because when different metals are brought into contact a galvanic action is set up; second, because block tin pipes have been known to be eaten through by water in consequence of the presence of nitrates (De CHAUMONT).—I have the honour to be, Gentlemen, your obedient Servant,

W. SEDGWICK SAUNDERS.

13, Queen Street, Cheapside,
October 30, 1881.

THE ACTION OF WATER UPON LEAD PIPES.*

LEAD has been employed in the manufacture of conduit pipes ever since the distribution of water in towns was first established by the Romans, the first aqueduct, the Appian, according to Varro,† being constructed in the year of Rome 442.

From that period leaden pipes have been in constant use, all the water services in the interior of ancient towns being made of that metal.

Each consumer had his branch connected with the reservoir or basin of distribution common to all the inhabitants of a district, and leading to his dwelling.

The public fountains were supplied in the same manner. The pipes which united the private to the public water works were invariably made of lead. (See Frontin,‡ who gives dimensions of the leaden pipes laid down in Rome.)

This mode of circulation necessitated very long leaden water pipes, and was used in Paris until within the last few years; it still exists in Rome, at Claremont-Ferrand, and in several other towns.

In the middle ages, and until the end of the 18th century, public supply pipes were made of lead, and many of this material were found in Paris some years since, dating from the time of Philip Augustus.

The employment of cast pipes became general about 1782, at the time of the establishment of Chaillet's works

and of the Gros-Caillois, by the Brothers Perier. From those remote times up to that period no danger whatever had been discovered in the use of lead. Neither Pliny, Frontin, nor any of the old historians, ever pointed out the slightest injurious effect traceable to it. It was the same in the middle ages and in modern times.

Only within the last few years an attempt has been made to alarm the public by endeavouring to show that the use of lead pipes is dangerous; the water, it is said, is impregnated with a small quantity of lead, which creates a slow, but pernicious, action upon the health of the consumer. This year the war against lead ("*La guerre au Plomb*"), the name given to this crusade, has made great development and caused considerable uneasiness in the minds of Parisians.

It became, therefore, my duty to examine what foundation existed for these charges, and I have done so with the help of M. Felix Le Blanc, a distinguished chemist and gas-examiner. M. Boudet was entrusted with a similar investigation for the Board of Health.

I must first clearly state the case and give the facts concerning the distribution of water, both public and private, in this city. The following statistics, dated 31st March, 1872, relate to the public services, viz:—

| | |
|----------------------------|-------------------|
| Cast iron pipes | 1,333,184 metres. |
| Tarred sheet iron pipes .. | 63,126 " |
| Lead pipes (about) | 3 000 " |
| Total | 1,399,310 " |

It is thus apparent that the main pipes are out of the question, and that "*La guerre au plomb*" would be objectless if there not also existed a network of short connecting pipes of very small diameter, and which, almost without exception, are made of lead.

These small pipes connect the main pipes with the draw taps; their network may be sub-divided thus:—

| | |
|---|--------|
| 1. Pipes connecting the Public Buildings | 152 |
| 2. Do. the Circuit | 14 |
| 3. Pipes connecting the Municipal Buildings:— | |
| • Water Posts, "à repoussoir" | 224 |
| Draw Wells | 33 |
| Street Fountains | 436 |
| Hired Fountains | 26 |
| Bureaux de Stationnement | 155 |
| Various Municipal Establishments .. | 167 |
| Religious Buildings | 49 |
| Schools and Colleges | 247 |
| 4. Charitable Institutions | 1357 |
| 5. Private Houses of Subscribers to the | |
| Town Supply | 37,889 |
| Total | 39,495 |

Most of the leaden pipes, therefore, are chiefly employed to connect private houses with the main supply pipes.

In the foregoing calculation, those municipal supplies are omitted which are never used for drinking purposes, for example, monumental fountains, flushing pipes under the footways, corner posts, watering jets, fire plugs, steam pumps, and urinals, 8277 in number, nor for watering the streets or the garden, which are not less numerous.

The leaden branch-pipes connecting dwelling houses with the main supply number about 39,500, and their average length may be put at 40 metres,† and their total length at 1,580,000 metres.

In spite of the great complexity of this network, every drop of water drawn for domestic use runs through a very small length of lead pipe, say 5 metres when drawn from the standpipes in the street, or at most 100 metres when taken in a private house.

In the case of houses that are occupied, the longest

* Pressure fountains or ordinary pumps with handles.—W.S.S.

† A metre is 39.37 inches English.—W.S.S.

* Paper by M. Belgrand in the *Transactions of the Academy of Science*, vol. lxxvii, November, 1873.

† Varro, *Marens Terentius*, a learned writer at Rome, B.C. 116.—W.S.S.

‡ Frontinus, *Sextus Julius*, a Roman statesman and author, in the latter half of the first century, wrote a treatise "*De Aqueductis*," still extant.—W.S.S.

period for the water to remain in the leaden pipes can be estimated thus:—

Houses having unlimited { 9 hours during the night.
supply { From 5 to 10 mins. during day.
Gaaged supply { from 3 to 6 hours at the most.

As will be seen further on, the time the water is in contact with the interior surface of the pipe is too short for the lead to be attacked.

I have already stated that in the network of main pipes there are about 3 kilometres* of lead piping. These are from time to time removed, and on examination their interior surfaces are invariably found to be perfectly smooth and without any trace of corrosion.

I now exhibit two pieces to the Academy; one comes from the service pipe of the Faubourg Saint Antoine, laid down in 1670, at the time when the pump of the Bridge of Notre Dame was erected; it is therefore more than 200 years old, and in the interior the impression of grains of sand is still to be seen; the other was taken up from a side street of Saint-Germain Market; it is somewhat less old, but equally unblemished.

It may be added that the leaden pipes become firmly and rapidly coated with a thin crust which prevents the water coming in contact with the lead. I place before the Academy for inspection a piece of pipe upon which this is distinctly seen. I visited at the factory of M. Fortin Herrmann, contractor for public works, the dépôt for old and disused lead pipes, where numerous fragments of these branches are to be found, and did not find one piece in it which was not in this condition: the internal surface of the lead being perfectly smooth, and covered by a thin very adherent coating of carbonate of lime.

The harmlessness of leaden pipes appear to me proved by these facts, which explain why they are in use in all the towns of France, and in most European cities, without ever having given cause for complaint.

I have, however, by direct analysis, sought for lead in all waters with which Paris is supplied, and in these analyses M. Le Blanc was good enough to lend me his valuable aid. The experiments were first made upon the public waters of Paris drawn at the following points:—

1. Seine water at the Hôtel Dieu, from a lead branch 200 metres long.
2. Seine water at No. 74, Avenue d'Orleans, lead branch of 100 metres long.
3. D'Ourcy water at the Hospital des Récollets, pipe 130 metres long.
4. Dhuis water at No. 40, Avenue de Clichy, pipe 20 metres long, consumption of water per diem 250 litres.
5. Dhuis water at No. 25, Rue de Moscow, lead pipe 40 metres long.

A sample bottle of 5 litres of each kind was sent to M. Le Blanc, who reported:—

"Sample received 16th August, 1873. Not any of these clear and colourless waters give an appreciable colouration with sulphuretted hydrogen; not a trace of lead is found in the residue obtained by evaporation in a platinum capsule. The same remarks apply to the sample received on September 1st, and to that of October 1st.

It must be concluded from this first series of experiments that the public waters of Paris, drawn at the extremity of the leaden branches, do not contain a trace of the metal when the house is inhabited, that is to say, when the water does not remain in the pipes more than nine or ten hours.

M. Le Blanc has undertaken other experiments, by leaving the lead in water for a much longer period. I quote his own words:—

On the Action of Waters Upon Lead.

Chemists have long known with what facility lead becomes oxidised when immersed in distilled water in con-

tact with air. Very small white shiny crystals of the hydrated oxide of lead are very rapidly formed, their quantity augmenting until a copious sediment at the bottom of the vessel has formed; the same obtains with pure rain-water.

On the contrary, water containing a given quantity of salts, principally from selenitic wells, does not attack the lead under the same conditions at all.

Such are the results of experiments made by Professors of Chemistry during the last forty years in public lectures, and M. Dumas never omitted to place them before his class at the Sorbonne.

Chemists have often remarked upon the harmlessness of lead with regard to potable waters, circulating in pipes of this metal, because of the saline matters which preserve the metal from oxidation.

No doubt it would be difficult to give an explanation of these facts, but they seem of the same kind as those which have been established with regard to iron, which can be preserved without oxidation in distilled water, even when aerated, if only a few drops of an alkali be added to it, whilst it is oxidised rapidly in pure aerated water. But it is curious to observe that by augmenting to a certain extent the proportion of alkali, oxidation can be facilitated.

It is well known how much the peculiarities pointed out by M. Gaynard in the case of the water pipes at Grenoble, have occupied chemists during the last forty years.

It becomes therefore of importance to ascertain whether the purest potable waters contain sufficient saline matter to preserve the lead from oxidation.

The following table shows that very pure water, such as from the wells of Grenelle, possessing much less saline matter than water from the Seine, has yet the power of preserving the lead from oxidation. The water in question shows from eight to ten degrees of hardness.

It will be seen that the waters marking even less than one degree of hardness still preserve this same quality. Indeed, rain water itself cannot attack lead, if it has not been collected with the greatest care, and after prolonged washing by the atmosphere by previous rain. However little rain water may indicate by reagents the presence of the salts of lime, we find that it does not act sensibly upon lead. When rain water does not give any reaction with lime reagents, it rapidly commences to attack the lead in the same way as distilled water does.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY

General Meeting, October 27, 1881.

Mr. J. W. SWAN, President, in the Chair.

The minutes of the last meeting were read and confirmed. The Treasurer's statement was presented.

The Committee's report was then read.

Mr. SWAN—I had intended, as the notice of the meeting states, to make a communication to-night on the subject of "Voltaic Accumulation;" but since I spoke to our Secretary on the subject, my time has been so much occupied in connection with the Exhibition in Paris, that I had either to bring the subject before you in a very incomplete state, or to postpone it till a later date. I have chosen the latter course. I intend at the December meeting to read the paper which I had purposed reading to-night; and as the Paris Electrical Exhibition was the cause of my shortcoming, I will make amends to some extent by giving you to-night a short account of it drawn from my personal recollections.

The Exhibition, as you know, is an International Exhibition of objects of interest in connection with electricity,

* A kilomètre is 1000 mètres.—W.S.S.
† Carbonate of lime.—W.S.S.

both in its scientific and practical aspect. It is held in the Palais de l'Industrie, a building of a permanent kind standing in the Champs Elysées, stone walled, glass roofed, and in general arrangement like other International Industrial Exhibition buildings. It is very large, and one of the feelings that the sight of it excites is wonder that a science so young as electricity should have already given birth to such a multitude of objects not only scientifically interesting, but useful in every-day life, as are required to fill this immense building, and with which it actually is filled.

One-half of the Exhibition is occupied by the exhibits of France, and the other half by the exhibits of other nations. Of these, Belgium, Germany, England, and America are chief, both in the number and importance of the objects exhibited.

As you approach the Exhibition at night, you can see from a great distance the sky above it lit up by the silvery light which streams upward through the roof, and illuminates in the most wonderful way mist and smoke, and shows with extraordinary distinctness all the movements of the air currents in the neighbourhood of the building, giving them an appearance of whirling clouds of smoke. Besides this welling up of light through the roof, two great beams of 50,000 candle power stream from it horizontally as from a great lighthouse; you have, therefore, no difficulty in discovering, even in the darkest night, the whereabouts of the Exhibition.

Further help is afforded by the electric railway which you meet on your way to the Exhibition. The station is brilliantly lighted by electric lamps, and you enter a tramcar very like an ordinary tramcar in appearance. The force which propels it is supplied by a dynamo-electric machine, fixed at one end of the line. The electric current from this stationary dynamo is conveyed (by sliding conductors running in overhead slit brass tubes, and connected with the car) to a second dynamo placed under the floor of the car, and connected with its driving wheels by a chain band. The foot of a horn, the turn of a handle, and in two minutes, without either smoke or noise, you are landed in the electrical fairland. You are attracted first by the brilliancy of the illumination as you enter the building. The blaze of light in contrast with the darkness outside is overwhelming. Hundreds of electric lamps hung from the roof, planted on the tops of tall posts and placed on every coign of vantage, contribute to the dazzling effect. There is a tremendous din of machinery at this point, because it is near where the numerous steam engines and gas engines are placed which drive the still more numerous dynamo-electric and magneto-electric machines. There are as many as sixteen dynamo-electric machines driven by one gas engine—a pair of coupled cylinders of 50-horse power—working most beautifully. Gas engines of every size abound, most of them driving dynamos, but the heavy work is done by the steam engines, of which there is a great variety, and many splendid specimens of mechanical work. Conspicuous by their number among the dynamos are of course the Gramme machines. I suppose there are hundreds of Gramme-dynamos working, many of them most beautifully grouped for compact and convenient driving, and employed chiefly to work lamps and some other dynamos for obtaining motive power. All the makes of dynamo-electric machines are represented, most of them very largely. Siemens's apparatus is here, there, and everywhere. There is a grand array of Brush machines, and among these two capable of supporting forty lamps in series, having probably an electro-motive force of nearly 2000 volts—that is, a tension equal to that which would be produced by 1000 Grove cells. There are a great number of magneto-electric machines of an improved type constructed by De Meritens, much used for lighthouses. There are several unusual forms of dynamo, such as the Bürgen machine, the Culcheth machine, and a Swedish machine in which the stationary magnet is inside as well as outside the armature; but the most unique machine,

not from difference of principle, because they are all alike in principle, but from its unusual appearance and its great size, is the Edison machine. This machine is probably the largest dynamo-electric machine ever yet made. Its armature weighs nearly three tons, and is geared directly to the axle of the steam engine which drives it—an Allen-Porter engine of 100-horse power, and making about 350 revolutions of the crank per minute. Usually, as you know, the armature of the dynamo is small in diameter, and in order to obtain the necessary surface speed for the development of sufficient tension in the current produced, a great speed of rotation is necessitated, and to obtain this belts have to be employed at a sacrifice both of power and safety. Clearly the right thing in the development of the dynamo is to make the armature of large diameter—why not the fly-wheel itself, and of a like diameter?—and then a comparatively slow rotation, such as can be obtained directly from the crank axle of the engine when going at a moderate speed, will give all the necessary surface speed for the armature thus expanded.

Engines driven by electricity occupy an extremely important position in the Exhibition. There are numerous small machines, such as sewing machines, driven by Deprez motors, fed by the currents from Gramme machines. As this motor gives a speed of several thousand revolutions per minute to the pulley attached to the armature, it is extremely convenient where high speed is wanted.

Among moving mechanism of a light kind there are electric clocks without end, both to work independently and to govern other clocks. The jingle of clocks and chimes worked electrically is perpetually on one's ear. I need hardly say that the clocks are worked by voltaic cells, for the most part by the Leclanché cell, than which nothing that I saw at the Exhibition does better for such purposes, where short spasmodic action with intervals of rest is required, and where durable effectiveness is necessary.

But the most striking novelty among machines is not the numerous sewing machines and clocks and other machines of a light description driven by electricity, but the heavy machinery—the railway cars, the electric ploughs, the planing machines, the lathes, the looms, the rock mills, the pumps throwing out a perfect torrent of crimson water, the punching machines, the hammers, and a multitude of other large machines. The way in which these ponderous machines move by invisible agency as though by magic, strikes one as very remarkable, and as foreshadowing a great future for electro-motive engines.

In the matter of telegraphic apparatus it is quite clear that we were by no means behind our neighbours. The English telegraphic exhibits were decidedly the finest in the place. In France they use Hughes's printing telegraph, which is not operated so quickly as the Wheatstone and Morse instruments in use on the English lines. When we come to telephones, however, the French, judging from the examples which come under one's notice at the Exhibition, are very much ahead of us. The telephones which one has been in the habit of hearing in England, and these which are to be heard at the Exhibition, bear very much the same relation to one another that moonlight does to day-light. Listening to the telephones in communication with the Opera House, the strength, the clearness, and distinctness with which every sound on the stage was heard is quite wonderful. For that interesting experiment the transmitting instruments are placed on the stage of the Opera House, six on one side and five on the other side of the prompter's box, and a pair of Ader telephones is connected with each transmitter.

One had fancied that it would be a difficult thing to construct a telephone which should not depend on the principle of electro-magnetic induction which is at the bottom of the action of the Bell telephone, but in the Exhibition there are two kinds of telephone, working upon quite a different principle: these are Edison's loud speaking telephone, and Dolbear's telephone.

In the Dolbear's telephone the vibration of the disc which emits the articulate sound is produced not by electro-magnetic attractions, but by purely electrical attraction, such as operates in the case of the pith ball electrometer.

As in almost all the various telephonic arrangements, a carbon microphone is employed as the transmitter at the sending end of the line. In circuit with the microphone are placed some voltaic cells, and in the same circuit, but at the receiving end of the line, is an induction coil, consisting of a primary helix of thick wire, and a secondary helix of thin wire, superposed on the primary helix, but not in circuit with it. The terminals of the secondary coil are connected by flexible wires with thin discs of metal placed a small fraction of an inch apart, and face to face. These discs are mounted in wood blocks, suitably shaped for holding up to the ear.

That being the arrangement, it is evident, that so long as the microphone is undisturbed by sound waves, a uniform current will circulate in the primary helix of the induction coil, which includes in its circuit the voltaic cells and microphone; there will be no electrical disturbance induced in the secondary helix, but the instant the carbon of the microphone transmitter is disturbed by sound, the fluctuations of current in the primary helix which ensue upon the disturbance taking place, are followed by corresponding fluctuations of electric condition in the secondary helix: no current passes because it is not a closed circuit—the air space between the discs interrupting it; but a state similar to that which subsists between the two coatings of a charged Leyden jar is induced in the opposing sound discs, which represent the two terminals of the secondary coil; these vibrate under the influence of varying attraction for each other corresponding with the variations in the flow of current in the primary coil, and exactly as the iron plate of the Bell telephone vibrates under the influence of a varying magnetic attraction.

But the climax of ingenuity is reached in Edison's telephone, which is on a totally different principle from either, in so far as the speaking part of the instrument is concerned, but I fear there is not time to go so much into detail as I am doing. I will therefore not describe it.

In the English Post Office Pavilion the oldest and the newest forms of telegraph instruments are to be seen, and much besides that is noteworthy. It is rich in objects of historical interest in telegraphy. The very youngest ideas in the credion, the submergence, and insulation of telegraph wires are there exemplified by models or specimens of the ancient styles. Worthy of notice are the tangled masses of submarine cable, dragged up from the bottom of the sea after long submergence; among these, some of the first Atlantic cable, twisted and contorted in the most fantastic and almost unrecognisable shapes. But it is impossible to dwell on details; had time permitted I should have taken you to the Belgian Department, and shown you a wonderful piece of electrical mechanism for the automatic registration of meteorological change, an apparatus which registers in a tabular form, and even automatically engraves every ten minutes, the height of the barometer, the temperature of the wet bulb and the dry—the force of the wind and its direction, and the rainfall; the action of the registering mechanism of all these different instruments is controlled by a single electric wire. It is a marvel of ingenuity and mechanical skill.

I should much have liked to have taken you to the Norwegian corner of the Exhibition, where is shown a collection of most ingenious apparatus, which, by means of vibrating balls and pulsating diaphragms submerged in water, illustrates, in a wonderful way, electrical and magnetic attractions and repulsions, the difference between attractions and repulsions being determined by the synchronism or non-synchronism of the pulsations of the diaphragm or the vibration of the ball.

It would have been interesting to have looked at the Paccinotti ring, the primitive pile, and other apparatus used by Volta—the bundle of bars of bismuth and anti-

mony built up by the hands of Melloni—at the table covered by movable wire spirals and rectangles which belonged to Ampère, and by means of which he demonstrated the attractions and repulsions of electric currents—at the wooden trough which Davy employed in effecting the decomposition of potash—at the coils and magnets which aided Faraday in producing an electric spark from magnetism, at the first bridges constructed by Wheatstone, at the original cells of Daniell, at the measuring instruments of Ohm, and at a great mass of other apparatus identified with the researches of Biot, of Arago, of Oersted, of Becquerel, and the whole host of worthies whose names are for ever enrolled in the annals of electrical discovery.

But much of interest as there is to be seen besides what I have mentioned, it is too late to extend our observations, and therefore, with whatever regret, we must perforce say good-bye to this, the latest and greatest of Industrial Exhibitions.

NOTICES OF BOOKS.

A Manual of Sugar Analysis, including the Applications in general of Analytical Methods to the Sugar Industry. With an Introduction on the Chemistry of Cane-Sugar, Dextrose, Levulose, and Milk-Sugar. By J. H. TUCKER, Ph.D. New York: D. Van Nostrand.

It is a remarkable fact that extensive as are the interests connected with sugar, and frequent, or rather constant, as are the applications of chemical science which they require, there existed hitherto no work in the English language dealing systematically with this branch of chemical analysis. Our apathy on the subject is the more remarkable when it is considered that we are far greater sugar-consumers than any other European country, and that the British Empire alone is probably able to supply more sugar than any other state in the world. France, Germany, and Austria, on the other hand, have been as active as we have been remiss; and thanks to their energy and perseverance, beet-root sugar, one of the weapons devised against us by the first Napoleon, has become a formidable rival to the true cane-sugar. We say "true" because, although analysis has hitherto not succeeded in showing any distinction between the saccharose of the cane and that of the beet, many persons can distinguish the two by the taste. Bees, we understand, where they have the choice, will crowd to cane-sugar and leave beet-sugar untouched, and a suspicion is gradually gaining ground that the physiological action of these two sugars is not identical.

The author sets out with a summary of the chemistry of the sugars as a class, and then gives a more especial description of saccharose, to which he devotes an entire chapter, of dextrose, levulose, and invert sugar, and of lactose. We venture here to propound a question: Starch, it is said, in any of its forms, when taken as food, cannot be digested until converted into sugar. Why, then, are the physiological actions of starch and of sugar so different?

Dr. Tucker proceeds in the next chapter to the determination of the specific gravity of solutions of sugars. It is somewhat remarkable that he omits all mention of Twaddle's hydrometer whilst speaking at length of the very inferior instrument of Baumé, which has been so justly denounced by Professor Bolley. In the chapter on the determination of cane-sugar by optical methods, he describes the saccharimeters of Mitscherlich, Soleil-Duboscq, and Soleil-Ventzke, Wild's polarisbrometer, the "shadow saccharimeters" of Duboscq and Schmidt and Haensch, and the method of Clerget, with the accompanying table. He states in a note that this process

(Clerget's) is entirely inapplicable when any optically active body is present besides cane sugar or invert sugar, and also if the invert sugar itself exists in an inactive condition as regards polarised light. To this criticism we cannot subscribe.

The chemical methods for the determination of cane-sugar next follow. The process of Peligot is not regarded as very accurate; extraction by alcohol gives good results where the quantities to be dealt with are but small. The fermentation process is justly pronounced "open to many objections." The processes for the analysis of raw sugars and syrups are the best known, and they are ably and clearly described. Still, we fear that they will under very possible circumstances prove unsatisfactory in practice. Further research is needed before the analyst can find himself in possession of methods suitable for every possible mixture of a class of bodies so nearly related in composition and not marked by any very striking reactions. An important section is devoted to the detection of two modern and increasing frauds—the addition of dextrin and of starch, or corn-sugar, to raw or refined sugars. Dextrin is added to raw sugars to give them a higher polarisation: 0.40 per cent of dextrin raises the optical standard 1 per cent. For its qualitative detection the author adds to a concentrated solution of the sample alcohol at 95 per cent. A white, thread-like coagulum shows the presence of the adulteration. Unfortunately, calcium sulphate gives a similar result. Iodised potassium iodide gives a vinous red, or violet colour, with some samples of dextrin, but not with all.

Starch or corn-sugar is now, at least in America, added in large proportions to sugar, syrups, preserved fruits, &c., and goes under the euphemistic name of "new process sugar." Its price is unfortunately very low—about 3d. per lb.—so as to leave a large margin for the unscrupulous. We may here remark that, according to the experiments of Professor Nessler, this substance is decidedly unwholesome. The author admits that there is no accurate method for the quantitative determination of this adulterant. Its presence may be qualitatively detected by attending to the three following points:—Sugars mixed with corn-glucose on solution in water leave white particles of the glucose undissolved. If a sugar adulterated in this manner is examined with the polariscope, the reading does not remain constant, but gradually becomes less. A refined sugar mixed with starch-sugar will show too high a percentage by the saccharimeter, so that the results appear more than 100 per cent. Two chapters are devoted to animal charcoal. Amongst the synonyms of this substance the author omits the name "spodium," which it commonly bears in Germany. The following passage deserves especial notice:—"There has been a method proposed in France for the estimation of cane-sugar in raw sugars, known as the *four-fifths method*, and is, I believe, used to some extent in commercial analysis. It consists in taking four-fifths of the ash as the number expressing organic matter not sugar. The sum of this—the ash, water, and glucose—subtracted from 100 represents the cane-sugar. The method is not worth mentioning, except as a curious example of the aberrations to which the human mind is subject." This process outdoes even the so-called "commercial method" of determining phosphoric acid in coprolites, superphosphates, &c., viz., by adding ammonia and accounting for the entire precipitate as tricalcic phosphate!

Dr. Tucker's work is well illustrated, and in case of some of the less common instruments described and figured, the address of the maker is given in a footnote. The getting-up of the book is excellent, with, perhaps, the exception of the index and of certain tables, which are in an uncomfortably small type. The work decidedly supplies a want which must long have been felt, and it places in the hands of the profession information which must otherwise be sought up, at great outlay of time, in the foreign journals.

CORRESPONDENCE.

WASH-BOTTLE.

To the Editor of the *Chemical News*.

SIR,—Since the appearance of Mr. M. H. Foye's letter in the *CHEMICAL NEWS*, vol. xlv., p. 304, I have examined at Messrs. Townson and Mercer's a specimen of his wash-bottle, of which I previously knew nothing. I find that it is very similar to mine; but inasmuch as the valve in mine is worked by the thumb, thus leaving the first finger free to move the jet in any required direction, I think it is rather more convenient than Mr. Foye's, in which the valve is worked by the first finger. My wash-bottle can be obtained from Messrs. Becker, 34, Maiden Lane, Covent Garden.—I am, &c.,

A. E. JOHNSON, Assoc. R. Coll. Sci. I.

St. George's Hospital, Dec. 29, 1881.

STRAW DYEING.

To the Editor of the *Chemical News*.

SIR,—I have experimented on straw very considerably, but I find that it has very little affinity for indigo and aniline-blue, although methyl-violet has a strong affinity. I have used most of the mordants, but still indigo extract does not seem to dye only a green, and then more dye is required than would make the dyeing with indigo remunerative. Could you suggest any method or do you know of any book that treats on straw dyeing. Beautiful colours are obtainable on straw, but the dyes (there are only two) keep it a secret.—I am, &c.,

Geo. Fyson.

GLYCERIN.

To the Editor of the *Chemical News*.

SIR,—In the *CHEMICAL NEWS*, vol. xlv., p. 316, glycerin is mentioned as an agent for the preservation of meat, &c. If worthy of your notice, I can say that some forty years back, the late R. Warrington, of Apothecaries' Hall, and myself, made experiments upon the subject, and he proposed patenting the process. I do not know or remember that he went so far.

I note your remark as to the present rising in prices of glycerin.

I also call to mind a lecturer at the Society of Arts, some twenty years since, said glycerin would shortly become part of the food for fattening pigs.—I am, &c.,

J. B. ANDERSON.

S soap Works, Southwark, Jan. 2, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Journal für Praktische Chemie.

No. 6 and 7, 1881.

Communications from the Chemico-Agricultural Laboratory of the University of Königsberg.—II. Rithauhen.—These consist of memoirs on the albumenous bodies of the hazel nut, walnut, candle nut, and of radish seed, and on the distribution of myronic acid in the seeds of *Brassica napus* and *rapa*.

Komenic Acid.—Dr. T. Reibstein.—The author has studied komenic ethyl-ether, acetyl-komenic ethyl-ether

THE CHEMICAL NEWS.

VOL. XLV. No. 1155.

ON CERTAIN INDIGENOUS DRUGS OF INDIA.*

By Surgeon C. J. H. WARDEN,
Chemical Examiner to Government, and Professor of Chemistry,
Calcutta Medical College.

Gloriosa superba.—The isolation of *Superbine*, the active principle of *Gloriosa superba*, was recorded in the last report. When purified it is a yellow non-crystalline neutral principle, to which the formula $C_{52}H_{60}N_4O_{17}$ has been assigned. It is readily soluble in water, alcohol, chloroform, and dilute acids: with tannic acid it gives a white precipitate, but is unaffected by other reagents. It is extremely poisonous, 0.0107 of a grm. being a fatal dose for a large cat. The following is a list of the substances which are found associated with *Superbine* :—

| | |
|--------------------------|-----------------------|
| Alpha-resin | $C_{30}H_{39}NO_{14}$ |
| Beta-resin | $C_{17}H_{35}O_2$ |
| Gamma-resin | |
| Fluorescent principle .. | |
| Salicylic acid | |
| Methyl salicylate | |

Alpha and gamma are acid resins; beta-resin is neutral; all are physiologically inert. A detailed account of the research has been published in the *Indian Medical Gazette*.

Thevetia Nerifolia.—No reference to the fact of a poisonous principle having been isolated from the seeds of *Thevetia nerifolia*, the exsile or yellow olivander, is made by any of the recent authorities on Indian indigenous drugs. In the *Indian Pharmacopœia* it is stated that a tincture made from the bark in small doses proved highly satisfactory in the treatment of intermittent fever, but that in larger doses it acts as an acrid purgative and emetic, and carried to a greater extent is evidently powerfully poisonous. The kernels are described as extremely bitter, and when chewed produce a slight feeling of numbness and heat in the tongue: by expression a pale amber-coloured, slightly viscid, acid oil is procurable, sometimes used as a cathartic by natives, but producing violent vomiting and hypercatharsis. Reference is made to a non-fatal case of poisoning by one of the kernels, and, from the symptoms detailed, the poisonous principle is classed with acrocarcotic poisons. In addition to the above information, Dr. Norman Chevers, in his "Manual of Medical Jurisprudence for India," mentions a case communicated by Baboo Kanny Lal Dey, in which a child playing under a *Thevetia nerifolia* tree picked up and ate one of the seeds, which much resembles the almond. In a short time vomiting commenced, but there was no purging. Within half an hour the child was insensible; the body covered with cold clammy sweat; the countenance pale, and the eyes deeply sunken; and within two hours the patient died convulsed.

A chemical examination of the seeds was therefore undertaken, and resulted in the isolation of a white crystalline glucoside, slightly bitter, with a faint metallic taste, rapidly followed by a pricking and numbing effect on the tongue. A centigram, injected into the stomach of a cat produced no apparent effects: a decigram dose, however, was fatal in twenty-five minutes, death being preceded by most violent convulsions. The oil obtained by acting on the kernels with benzene produced no effect on a cat in a drachm dose.

This research has, however, been very disappointing,

because I have recently ascertained that a glucoside was isolated in 1868 by Cl. Blas from the kernels of *Thevetia nerifolia*, and called thevetin, and the formula $C_{60}H_{84}O_{48}$ assigned to it. The results of the investigation were published in the *Bull. de l'Académie Royale de Médecine de Belgique* (Gmelin's "Handbook," vol. xii.). Thevetin dried over sulphuric acid is stated to contain six atoms of water, two of which are lost at 110° C. The percentage composition, calculated from the formula $C_{60}H_{84}O_{48}$, requires, carbon 60.3351, hydrogen 3.9106, and oxygen 35.7543 per cent, and with six and four molecules of water respectively—

| | 6H ₂ O. | 4H ₂ O. |
|----------------|--------------------|--------------------|
| Carbon | 57.4468 | 58.3783 |
| Hydrogen | 4.2553 | 4.1441 |
| Oxygen | 38.2979 | 37.4776 |
| | 100.0000 | 100.0000 |

The percentage composition obtained by me appears to differ somewhat from the above figures. The mean of eight ultimate analyses of thevetin dried at 145° C. gave the following results :—

| | |
|----------------|----------|
| Carbon | 57.4083 |
| Hydrogen | 7.4775 |
| Oxygen | 35.1142 |
| | 100.0000 |

By acting on thevetin with dilute sulphuric acid, Blas obtained thevetin, $C_{60}H_{70}O_{34}$, and glucose. I have repeated this experiment, but at present have not made any combustions of thevetin. I am also engaged in examining the leaves and bark of *Thevetia nerifolia*, which apparently have not hitherto been analysed. I would remark that in the abstract given by Gmelin of Blas's article no mention is made of thevetin possessing poisonous properties.

Abrus precatorius.—The examination of ruttee seeds, which, when made into needles, are used for cattle poisoning, has occupied considerable attention, but I regret that the active principle has not yet been isolated. The chemical examination of the seeds has resulted in the separation of a crystalline acid and oil and certain extractives. By acting on the seeds with boiling alcohol, a white crystalline acid is obtained, to which the name *abric acid* has been given, and the formula $C_{17}H_{24}N_2O_4$ assigned. This acid is slightly soluble in cold, but dissolves in boiling water, and crystallises out in delicate white microscopic needles. With alkaline bases it forms well-defined crystalline salts. The following is a brief resumé of the physiological experiments which have been performed :—

- Half a seed rubbed down with cold water, and the mixture hypodermically injected into a cat's thigh, produces fatal effects in from eighteen to thirty hours. The seeds weigh on an average two and three-sixteenths of a grain. For the first eight or ten hours after the injection no symptoms are apparently produced; a gradual disinclination for exertion then supervenes, which slowly increases until the animal is unable to move. The respiration becomes shallower and shallower; the animal lies on its side and slowly dies. No convulsive movements or twitchings of the muscles have been observed, and there is neither diarrhoea nor vomiting.
- An alcoholic extract prepared with boiling alcohol is inert.
- The residue left after the action of boiling alcohol on the seeds is also without effect.
- Abric acid and abrate of ammonia are inert.
- Some of the powdered seeds were distilled with water at a temperature of 100° C. Neither the distillate nor the residue left in the retort produced any symptoms.

* From the Annual Report on the Chemical Examiner's Department for the financial year ending 31st March, 1881.

- (f) An extract prepared by spontaneous evaporation with cold alcohol produced no effects.
- (g) An extract similarly prepared with ether produced fatal effects with the usual symptoms. In a second experiment, conducted apparently under similar circumstances, no effects were produced.

It would appear that a temperature of 100° C. destroys the activity of the poison.

Wrightia antidysenterica.—In my last report I stated that Baboo Ram Chandra Dutta, Second Assistant in the Laboratory, had re-discovered the active principles of kurchi bark. The bark of *Holanhena antidysenterica* was formerly imported into Europe under the names of "Cenessi bark," "Codaga pala," "Corta de palla," and Tellichery bark. In 1858 an alkaloid was separated from it by Haines, and seven years after the late Dr. Stenhouse again described the alkaloid under the name of Cenessine.

It is a curious fact that this alkaloid appears to have been thus twice re-discovered.

The purification of kurchicene being somewhat difficult, it occurred to Baboo Ram Chandra Dutta that an acetic solution of the crude alkaloid might be as efficacious as pure kurchicene. A solution was therefore prepared, containing three grains of kurchicene in each fluid drachm of the solution.

Dr. J. M. Coates, Principal of the Medical College, tried the effects of the extract of kurchi on some patients in the Medical College Hospital, and has kindly furnished me with the following note:—

"We have used kurchicene to a limited extent in this hospital, both in fevers and in dysenteries, though in very few of the latter. So far as we have gone, we have found that it has decided antipyretic effects in fevers.

"It is most effectual in those which have chylipoietic congestions. In these the tongue cleaned, the bile appeared in the stools, digestion improved, and the fever ceased, under drachm doses of the liquor, one to three times a day.

"It is less effectual where the spleen is enlarged and blood anæmic, though in one case it distinctly modified the temperature where quinine, even in large doses, had failed.

"In dysenteries, in half to one drachm doses, it was also beneficial.

"In the three acute cases the fever abated and the stools became fewer in number, more consistent in quality, and more bilious in character, but the blood and mucus were little affected. They abated for a time, but reappeared, again and again, in spite of the kurchicene.

"In the two chronic cases we had nearly the same result, though the benefit was less marked in these than in the acute.

"In dysenteries I hold it to be an excellent adjunct to our ordinary treatment of this disease, but it is not an entire substitute for these."

ON THE

ACTION OF WATER UPON LEAD PIPES,

BEING A

TRANSLATION FROM THE FRENCH OF M. BELGRAND.

By W. SEDGWICK SAUNDERS, M.D., F.S.A.,

Medical Officer of Health and Public Analyst for the City of London,
Late President of the Hunterian Society, &c.

(Concluded from p. 9.)

Action of Chemically Pure Lead on Different Waters.

The lead is immersed in water, and the liquid exposed to the air. About 25 grms. of pure lead, and 250 cubic centimetres of water are used. (See Table next page.)

* A gramme is equal to 15.438 grains troy.

† A cubic centimetre is equal to 0.99371, or nearly two-fifths of an English inch.—W.S.S.

Which salts are the most efficacious, when present in minute quantities, in preventing oxidation of lead in contact with water? Salts of lime alone are unquestionably so, even in the smallest proportions; in the absence of lime other salts are capable of protecting lead, in quantities of 0.1 grm. per litre. Nevertheless after from 24 to 30 hours the water becomes faintly coloured by sulphuretted hydrogen; but this oxidation soon ceases. The following experiments were made to ascertain the particular influence of different salts.

Solutions were made with sulphate of soda, chloride of sodium, chloride of potassium, sulphate of magnesia, the strength of each solution being 0.1 grm. per litre. The lead was immersed in these for 24 hours, when the water became coloured by sulphuretted hydrogen, but the solvent action did not continue, and it may be said that the solutions in question are without notable action upon lead, for, at the end of 10 days, the reagent did not produce any real precipitate. These experiments will be continued by varying the proportions.

We have, with M. Le Blanc, undertaken another series of experiments by operating upon water under the most favourable conditions for its contamination, and have obtained some traces of lead in the residue left by evaporation. As soon as this further inquiry is terminated I will forward the results to the Academy.

Upon the whole there is absolutely no danger of poisoning from the use of water flowing through leaden pipes.

It would doubtless be very difficult to compel, as has been suggested, the Parisian houseowners to replace the 1500 kilometres of lead branches at present existing in their property, since it is found that the interior of these pipes are perfectly smooth, without a trace of injury, and coated with a thin crust of adherent deposit, which prevents the contact of the lead with the water.

I do not think that any other mode of distributing water can be recommended, even to nervous people; the iron pipes so much used in London on account of their low price, are less suitable for Paris, first because the necessary joints and connecting pieces are not to be found in commerce, but especially as accidents from frost, more to be feared in Paris than in London, are more formidable with iron pipes than with lead.

Leaden pipes lined with tin have been lately recommended. These are very expensive, and possess the grave objection that in soldering the joints the inner tin casing (or lining) is melted, and creates obstructions in the pipe.

I have obviated this difficulty by causing the tin to be melted beforehand off those ends of the pipes intended to be soldered, for a length of 8 to 10 centimetres (three to four inches), in a sand bath heated to more than 227° C.,* the melting-point of tin, and less than 330° C.,† the point at which lead fuses. It is true that a small surface of lead is left unprotected by this device, but, in my opinion, for so short a length as to be practically unimportant. One cannot, however, advise the employment of these, since they are too novel for us yet to know all the disadvantages which they may possess. In reality none of these pipes can have any effect whatever on the health of the public. The administration has therefore adopted the only sensible course in authorising subscribers to use, at their own pleasure, and on their own responsibility, either the leaden pipes, or those of iron, cast or otherwise, or those in lead lined with tin; on the sole condition of giving to all pipes laid under the public roadway the thickness necessary to resist the pressure of the water.

At the same sitting of the Academy M. Dumas made the following communication:—

"M. Fordos has requested me to present to the Academy the paper that will be read later.‡ In complying with the desire of that learned chemist, and quite

* 227 degrees Centigrade, equal 440.6 degrees Fahrenheit.

† 330 degrees Centigrade, equal 626 degrees Fahrenheit. W.S.S.

‡ See the *Transactions of the Academy of Sciences of Nov. 10, 1873*

| Nature of the Waters. | Date of Immersion. | Observed Result. |
|---|--------------------|--|
| Distilled Water | September 27. | Considerable action, White Crystals of Hydrated Oxide of Lead formed. |
| Water from the Seine (1) | do. | No effect produced. |
| Water from the Dhuis (2) | do. | do. |
| Water from Grenelle Well (3) | do. | do. |
| Water from Ourcq (4) | do. | do. |
| Water from Arcueil (5) | do. | do. |
| Water from Belleville Well (6) | do. | do. |
| Northern Spring, Près St. Gervais (7) | do. | do. |
| Water from Well at Passy | do. | do. |
| Water from the Reservoir of Gulf d'Enfer à Saint-Etienne (granite formation). Hardness 1'44" (8) | October 8. | do. |
| Water from the Reservoir of Settens (Morvan) River of Cure. Hardness 0'96 (9) | do. | do. |
| Water of the Ourthe (Belgium) Devonian formation. Hardness 0'96 | October 15. | do. |
| Rain Water collected in Quai at Be- thune | October 8. | { No visible effect. Traces of Sulphate and of Lime. |
| Rain Water collected on the Reservoirs of Ménilmontant | October 28. | { The corrosion of the Lead was evident at the end of 24 hours, and went on increasing. Deposit very abundant on November 5. |

- (1.) At the mouth of the Aqueduct of Ménilmontant.
- (2.) In the middle of the stream, near the supply for the Orleans Railway.
- (3.) At the top of the well.
- (4.) In the middle of the Inner Circle Station.
- (5.) From the Aqueduct.
- (6.) House, 19, Rue Fessart.
- (7.) From near Mossins, behind Bastion 20.

- (8.) This reservoir generally contains 1,600,000 cubic metres of water.
- (9.) This reservoir has a capacity of from 19 to 20 millions of cubic metres.

NOTE.—The pipes encased in tin were not more attacked than the leaden town pipes. The well water of Grenelle was employed for comparative experiments.

accepting the results which he announces as to the effects of prolonged shaking of grains of lead¹ in contact with air and water, and also the inferences which he draws with regard to rinsing bottles, the Academy will allow me to make some remarks upon the contact of potable water with vessels or pipes of lead. I made long ago in my public lectures the following experiments. Five flasks being filled with grains of lead, I poured some water into each.

1. Distilled water.
2. Rain water.
3. Water from the Seine.
4. Water from the Ourcq.
5. Well water.

"I showed by the action of sulphuretted hydrogen (H₂S) that the water of the first flask gave evidence almost immediately of a trace of oxide of lead dissolved in it, while the flasks which contained water more or less charged with lime salts did not contain any."²

"The rapidity with which distilled water takes up lead is surprising; the effect produced by even traces of lime salts in preventing this contamination is not less so. One cannot forbear comparing these facts with those which M. Schloësing has observed with reference to the white clay which will remain indefinitely suspended in pure water, but which the very faintest trace of lime salts will precipitate."

"The properties of absolutely pure water are hardly yet known, and they differ, I dare say more than is supposed, from those of ordinary water."

The following note of M. Chevreul has been published in the *Comptes Rendus* of the meeting of November 17th, 1873.

"Want of time having prevented me from inserting in the Minutes of the meeting of November 3rd some observations in relation to the action of pure water on many

metals, which were suggested to me by the communication of M. Fordos and of M. Belgrand, I must ask the Academy kindly to allow the following observations to be inserted in to-day's Minutes."

1. Observations in Relation to Hygiene.

"In the *Bulletin des Séances de la Société Centrale d'Agriculture de France* (July 9th, 1873), in reference to a petition from M. de Laval to the Corporation of Paris, to do away with leaden pipes, I made the following remarks:—

"Our Vice-President, M. Chevreul, will recollect the remarks which he made at the Gobelins, upon the action of distilled water on lead and zinc, an action which is not exerted by hard waters which contain certain salts in solutions.

"He also will remember having told the Society that similar observations were made long before his own by M. Guyton de Morveau, who had noticed that pure waters acted not only upon lead but also upon zinc. It is to M. Guyton, added M. Chevreul, that the merit of the observation in question is due."

Furthermore, in the *Journal des Savants* (October, 1871, p. 488), one reads:—

"It may not be inopportune to draw attention to a fact not sufficiently known to the public, namely, that rain waters alter leaden and zinc vessels more than waters containing salts in solution, well waters for example. The result of this is that these latter waters may remain in a leaden vessel without attacking it, and without becoming poisonous, while rain waters, free from saline matters, dissolve oxide of lead and thus become poisonous. This observation quoted from Guyton de Morveau is perfectly true. I have verified it at the time of my investigation on the waters of the Bièvre."

"If particular circumstances had not prevented me from going to the Gobelins to-day to seek the results of experiments dating back to 1836, and which I will lay before the Academy in due course, you could have seen the effect of distilled water, as compared with that of well water, upon a sheet of lead, and also a similar difference

¹ Probably lead shot.

² If one takes some water from the first rain which falls after a dry period, it is found charged with lime particles which the later rains, having traversed pure air, do not contain; according to the rain-water chosen then, the effects may differ, still, as a whole, the rain-water of Paris is almost identical with the water of the Seine.

between iron and steel in distilled water, and the iron and steel in an alkaline liquid.

"I had occasion in 1844 to notice a fact relating to hygiene and to ordinary economy, which was, that in a great industrial establishment, the name of which it is unnecessary to give, they had invented a method of preparing calico with the sulphate of lead obtained in the preparation of the cotton weavers' dye, by the reaction of acetate of lead and alum. It happened that a Sèvres washer-woman, whose customers belonged especially to that part of Paris where the warehouses of dyed linen goods are situated, was greatly astonished to see the linen which she had washed come out black and discoloured from her wash-tub. The explanation was that she used soap lees prepared with a mixture of soda, of potash, and of sulphide of lime, and that this at once caused the formation of black sulphide of lead with the sulphate of lead in the clothes. I have narrated this fact in the *Comptes Rendus* of the meeting of September 16th, 1844.

"In 1841 I was directed by the Minister of Marine to examine, conjointly with M. Lebas, whose name is so closely associated with that of the Luxor obelisk in the Place de la Concorde, several methods of purifying the water for use in the navy. Among these methods was included that of distilling sea water by means of the apparatus of a Nantes operative. We discovered the presence of copper, derived from the metal of the condenser, in the water thus distilled; and after having ascertained that a drinkable water could be obtained from a sample giving a reaction with sulphuretted hydrogen by passing the water through a carbon filter, which, by capillary attraction, would take up the copper, we advised the authorities to instruct the doctor on board to have some stoppered flasks of one decilitre in capacity, containing a solution of a sulphate and oak shavings, so as to obtain a reagent capable of showing not only the presence of copper, but also that of lead; because the soluble sulphate in the water is transformed, after a few days, into sulphide by the soluble oxidisable matter of the oak wood."

II. Observations in Relation to the Arts.

"I remind you that the presence of a copper salt in the tissues of wool, which is intended, for example, to be subjected to the action of steam after being printed, causes it to assume an orange colour, because the sulphur of the wool produces a coloured sulphide, under the influence of heat and moisture." A brown or black sulphide will be produced if the tissue contain some salt of lead, as happened in 1844, when in the manufacture of some woollen tissues in Picardy, a weaver had used a gelatine which the maker had whitened with acetate of lead; and thus the impregnation of the warp with this gelatine caused the tissues, after being printed and passed through steam, to become stained.†

III. Observations in Relation to Chemistry.

"In 1837, I called the attention of chemists to a fact to which I attach great importance; it concerns the use of reagents in chemistry.

"I recognised that all alkaline reagents which were kept in flasks of white glass, in the manufacture of which, in order to give greater whiteness, fragments of leaden glass are largely used, contain from that source oxide of lead in solution. I thought it right, therefore, in the interests of science, to show the necessity of keeping the reagents of which I speak in future always in vessels of green glass. It is here not only a question solely of pure science, but also of toxicological analysis, and nobody will blame me for recommending an examination of the reagents used, knowing that the experts chosen to perform such analysis always make what are called blank experiments in order to avoid all errors, and especially those which might be due to the reagents employed.

"Since it is a scientific question, an important communication made at the last meeting on the influence of salts in causing the precipitation of white clay in suspension in water, encourages me to make the two following remarks:—

"The first is, that this communication proves the proposition that I have several times enunciated, and that quite recently, on the solvents. In fact, I have remarked that the moment a solvent takes up any substance in solution it becomes a different solvent from the original one; in other words, it can now dissolve bodies which it could not dissolve when in a state of purity, and this is the cause of one of the greatest difficulties of proximate organic analysis."

"The second is, that in the article, *Gold*, written for the *Dictionnaire des Sciences naturelles*, an article which appeared in 1825, in volume 36, I said, after speaking of a method of preparing the Purple of Cassius by the nitrate of proto-oxide of tin: 'I have several times noticed that the addition of a few drops of a solution of a neutral salt, such as sulphate of potash, at once brings about a deposit in a liquid which would have otherwise been several days without giving a precipitate.'

Conclusion.

"After having heard the advice given by M. Belgrand in inference to the conveyance of spring waters through leaden pipes,* I share his opinion as to the usefulness of leaden pipes on condition that a test is made in every case where it may be suspected that the water has remained too long in contact with the metal."

I have received the following supplementary information on the distribution of water in different towns:—

Glasgow.—Enormous supply of water from Loch Katrine. Hardness from 3 to 5 degrees. In consequence of the purity of this water, contamination with lead was much apprehended; however, the house pipes were made of this metal, as in Paris, and experience has shown that no inconvenience has resulted.—(Information given by M. Mille, Inspector-General of Roads and Bridges.)

Brussels.—Water derived from chalky sources, like the water of the Vanne. The hardness probably varies from 18 to 20 degrees. According to M. Maus, Inspector-General of Belgian Roads and Bridges, the public conduits are of cast-iron, the house pipes of lead. The harmlessness of the system is established, and yet a journal, published in Brussels, made a furious onslaught on the leaden pipes of Paris, forgetting those of its own town.

Lisbon.—Water of variable quality, in part very pure, showing only two or three degrees of hardness. The main services of cast-iron, house pipes of lead; the system was answering very well, till the "war against lead" broke out and disturbed the public mind.—(Information given by M. Larcher, Engineer and Peer of Portugal.)

Avalon.—Water from granite formation. Standard of hardness from one to two degrees. Public conduits of cast-iron, house pipes of lead. This method of distribution in use since 1847, and despite of the purity of the water, without any ill result. So-called centenarians are not rare in this pretty little town.

Decomposition of Water by the Electric Effluve in Presence of Nitrogen.—M.M. Dehérain and Maquenne.—The apparatus in which electric exchanges take place through one or two isolating envelopes may produce not merely the effluve, the phosphorescent light, and the rain of fire, according to the tension and the nature of the gas introduced into the apparatus, but even, if the isolating sides are moist, an electric manifestation closely resembling the spark. It is capable of combining nitrogen either with oxygen or with carbon.—*Comptes Rendus*.

* *Comptes Rendus*, December 26, 1837.

† *Ibid.*, September 16, 1844.

‡ *Ibid.*, December 26, 1837.

* The part of my paper to which M. Chevreul alludes has from lack of space not been printed in the *Comptes Rendus* of November 10, 1873. It will appear in the next communication.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, December 13, 1881.

J. P. JOULE, D.C.L., LL.D., F.R.S., &c., in the Chair.

Remarks on the Terms used to denote Colour, and on the Colours of Faded Leaves, by EDWARD SCHUNCK, Ph.D., F.R.S.

At the recent meeting of the British Association held at York, a paper was read by Dr. Montagu Lubbock before the section for anatomy and physiology on "The Development of the Colour Sense," which I had the pleasure to hear. The purpose of the author was to controvert the opinion of those who hold that the colour sense in man is not always what it is now, but that it has gradually been developed, the last stages of this development having taken place within historical times. It is supposed that the human eye was originally only capable of distinguishing black and white, and that the capacity of seeing the various colours of the spectrum arose by degrees, red being the first, and blue the last colour to be discriminated. Mr. Gladstone, in a paper published not long ago, goes so far as to say that the ancient Greeks, having no word for blue, were blind to that colour, and that it is only since their day that human vision has been so far developed as to perceive the more refrangible end of the spectrum. The author of the paper referred to arrived at the conclusion that there is no sufficient evidence to show that the faculty of perceiving colour has been acquired by man within historical times, a conclusion in which Sir John Lubbock, who took part in the discussion on the paper, entirely concurred. Whatever may have taken place in pre-historic times, there can be little doubt, I imagine, looking at the remains adorned with various colours in Egypt and elsewhere, that the more civilised nations of antiquity, though they had fewer pigments at their disposal than we have, were quite as capable of distinguishing colours as we are. It may indeed be asserted that so far as appropriate arrangement of tints in dress and other articles of daily use is concerned, no advance has been made since the times of the ancients, but rather that we have in this respect retrograded. Evolutionists tell us that we may obtain a good idea of what our pre-historic ancestors were, by observing the present state of savage and uncivilised races, a state from which we have in the course of ages emerged. So far, however, as the appreciation of colour is concerned no superiority on our part can be discovered, for whoever will, with an unprejudiced eye, compare the harmonious combinations seen in the articles produced by the less civilised nations of India and China, or by the natives of America and Polynesia, with the hideous contrasts and tasteless arrangements so often displayed in our articles of dress and furniture, will probably incline to the opinion that in this respect we may rather be called savages, and that the incapacity for appreciating colour harmony inherent in the Teutonic branch of the Aryan race has not been removed, but rather intensified by civilisation. Much has, indeed, been done of late to promote good taste in this as in other departments of art, though our progress has probably been retarded by the introduction of various artificial colouring-matters, the extreme brilliancy of which acts as a lure to the uncultivated eye.

Though much of the uncertainty which exists as to the precise meaning of the words used by the ancients to denote colour is of a philological kind, part of it is due, I think, to causes which are still in operation.

1. The ancients, having no fixed scale of colour to refer to, such as we possess in the spectrum, were unable to compare any given tint with that which it exhibits in its highest state of purity, whilst we, by means of the fixed

standard at our command, and with the assistance of the so-called chromatic circles and other appliances, can determine not only the exact position and shade of any given colour, but also the extent to which it is degraded or rendered impure, and though the general public very slowly adopts scientific terms and methods, still on the whole the tendency in our days is towards exactitude, and vague terms for objects and sensations are more and more falling into disuse.

2. In one respect the ancients must have laboured under the same disadvantage in determining the value of colour as we moderns do. We very seldom see one colour alone, but generally two or more in juxtaposition, and contrasted, and by contrast the effect of each colour on the human eye is considerably modified. Complementary colours, when seen in close proximity, heighten one another. Green next to red will appear much brighter than when placed close to blue. A colour of average purity will appear dull when compared with a brighter colour of the same hue, while it will seem bright when seen alongside a more dingy shade, and so on. Unless great care be taken, therefore, we are liable to become inaccurate when describing a colour, though, on the other hand, it may be doubted whether, if the human eye were so constructed as to see only one of the colours of the spectrum, we should from the absence of contrast be able to appreciate that colour correctly.

To the fact that we almost always see colours in contrast must be ascribed the habit which men have of speaking of "beautiful colours." No one who has thought on the subject need be told that a simple sensation cannot be strictly speaking beautiful. It is only by combination, contrast, and harmony of sensations that we arrive at beauty. To talk of a beautiful sound, such as a single note of a musical instrument, would be absurd; it is only a combination of sounds that can be called beautiful. The terms "beautiful smell," "beautiful taste," would cause the most ignorant to smile, though it may be contended that a dish uniting various flavours, or a perfume composed of well-assorted scents might be called beautiful. We look at the spectrum thrown on a screen, and say it is beautiful, but it is the effect of the various colours seen in juxtaposition, and the exquisite shading and melting of one into the other that we admire. When we speak of the beautiful colours of sunset, we forget that a fine sunset is in fact a grand chromatic display. We see the fiery red of the fleecy clouds and the deep blue of the sky contrasted with the green of the foliage, and the brown of the tree stems, followed by a flood of yellow light on a cool grey ground in the heavens, while the gloom of night is settling over the earth beneath, and the eye is pleased and satisfied. Were we to see the sun like a ball of red-hot iron set through a coppery sky over a sea of blood washing a coast line of red rocks overgrown with red seaweed, it is certain we should not speak of the beautiful colours of sunset. Let any one, to test what I maintain, look at any colour, however brilliant and pure, through a tube blackened inside, and say whether it appears beautiful. It is the great activity of the eye, which during our waking hours is constantly roaming from object to object, seldom seeing the same thing nor the same colour for more than a few consecutive moments, that deceives us.

3. Much of the confusion as regards the names of colours arises, as it has doubtless at all times arisen, from the habit, difficult to explain, of using inexact designations, and even applying names to colours which we know to be incorrect. Poets, for instance, call gold red, though it is always yellow. We speak of white wines and red wines, though in reality, as we are well aware, they are yellow and purple, so that in a thousand years hence it may be possible for a literary man to say that we were colour-blind, our eyes having not yet acquired the capacity to see yellow and blue, yellow appearing to us colourless and purple red; and he may in support of this assertion quote the line of a distinguished poet now living who speaks of the "costly scarlet wine," a term which is still

more precise and emphatic than simple red. In the course of an investigation, undertaken a short time ago with another chemist, I found that my collaborator and myself never exactly agreed as to the names to be given to the colours we saw. The series which he named blue, violet, purple, crimson, red, orange, I called violet, purple, crimson, red, orange, yellow, i.e., what was to his eye blue was to mine violet; his violet was my purple, and so on. There was no reason to suppose that our perception of colour differed, the difference was in my opinion simply one of terms.

The writings of ancient authors abound with instances of the use of colour names which are seemingly incorrect. We find in "Horace" (Book IV., Ode 1) the lines:—

Tempestivus in domum
Paulli, *purpureis* ales oloribus
Comiss abere Maximi,
Si torrete jecur queritis idoneum.

Another author says:—

Purpurea sub nive terra latet
Brachia purpurea candidiora nive.

We are told by scholars that in these cases *purpureus* means bright, shining, but it still remains to be explained why a word, which generally denotes a positive colour, whatever that colour may have been, comes in a few instances to be applied to white objects, such as swans and snow. Of course the definition of a word may be so extended as to include any number of widely different meanings, some of these meanings being perhaps due to a mistaken use by authors. It would probably not be difficult to find passages in modern authors in which the word blue sometimes means green, sometimes violet. I met with a case in point recently on reading again Goethe's delightful autobiography "Wahrheit und Dichtung." The author, when a young man, was skating on the river on a bitterly cold winter's day. "I had been on the ice," says he, "since early morning, and was therefore, when my mother later in the day drove up to admire the scene, being only lightly clad, almost frozen. She sat in her carriage wrapped in a red velvet fur mantle, which, held together in front with thick gold lace and tassels, looked magnificent. 'Give me, dear mother, your fur cloak,' said I, without much consideration, 'I am fearfully cold.' She, too, did not consider long, and the next moment I had put on the cloak, which, reaching nearly to my feet, being of a purple colour, trimmed with sable, and ornamented with gold, suited very well the brown fur cap which I wore." Here it is evident that Goethe calls the same object first red, then purple, and yet Goethe was not colour-blind; he wrote, as everyone knows, a work on the theory of colours.

4. Part of the vagueness and uncertainty attending the terminology of colour may be ascribed to a tendency we are all more or less liable to, that of describing colours in figurative and metaphorical terms. The habit, no doubt, arises from the pleasure we feel in comparing two objects, both of which are agreeable to the sense of sight. We speak of a girl having sky-blue eyes and cherry-red lips, whereas slate-coloured and black-red would be more correct. How often we hear the expression, "he turned as white as a sheet," whereas the human skin is never under any circumstances, even after death, as white as a sheet. To say "he turned of a dirty yellowish white," would be nearer the truth, though the expression might be thought somewhat inelegant. Poets and others speak of golden hair and silvery locks, but human hair, though it may be bright, glistening, and so on, never reflects light in the manner peculiar to metals. Numerous examples of the same kind will occur to everyone. If, therefore, we meet in ancient authors with expressions relating to colour which seem exaggerated and out of place, we must make some allowance for the tendency shown by men at all times to compare one beautiful object with another beautiful object, or one terrific object with another terrific object, without regard to exact literal truth. Generally

speaking, I think we may safely say that no terms denoting colour, wherever met with, are to be considered strictly correct and appropriate unless they are referred to some fixed and known standard. The errors due to actual colour blindness need hardly, I think, be taken into consideration, since the hues which the colour blind are unable to distinguish lie so far apart as to make it difficult for anyone with normal eyes to conceive the possibility of so great a defect.

The brilliant tints exhibited by the decaying foliage of the trees in this neighbourhood in the course of the autumn, forming a chromatic display such as those living near manufacturing towns have few opportunities of witnessing, have led me to think a little on the cause of the formation of these colours and its possible connection with chlorophyll, on the chemistry of which I have lately been making some experiments.

The colour of the leaves of plants is a phenomenon which is probably never quite stationary at any period of their development. When lying rolled up in the leaf bud they are like underground shoots and other parts of plants that have not been exposed to light, almost white; nevertheless they already contain a colouring-matter called *etiolin*, the alcoholic solution of which is yellow and shows absorption-bands similar to those of chlorophyll. Whether this etiolin on the leaf unfolding passes over into chlorophyll and whether it continues to be formed during the further stages of development is not known. All we know is that when the leaf expands it immediately becomes green from the formation of chlorophyll. It is, however, evident that more than one colouring-matter is formed after exposure of the leaves of plants to light. The colour due to chlorophyll alone is plainly seen in its purest state in the tender exquisite green of the young beech leaf or blade of corn. Other leaves, such as those of the oak, before attaining maturity have a decidedly yellow tinge, due it is supposed to the presence of an unusual proportion of *phyllanthin*, the yellow colouring-matter always accompanying chlorophyll. Indeed, the lively contrast of tints seen in the foliage of the woods in early spring, the yellowish hue of the oak, and the pure green of the beech and larch relieving the sombre colour of the fir tree and the yew, affords one of the most pleasing sights of that delightful season. In early summer the young shoots of some trees, such as the oak, the sycamore, and the thorn, as well as the young leaves near the summit of each shoot, are tinged of a lively red, passing by degrees into the green of the mature leaves. The fruit wings of the sycamore are for many weeks in the summer similarly tinted, and the effect of the pink blush gradually shading off into the pale green of the wing tips is one that painters might introduce with advantage into their pictures of still life. This red colour is said to be due to *erythrophyll*, the colouring-matter formed in some leaves in the autumn, but whether the substance is in both cases really the same may be doubted. At the height of summer the foliage of trees displays a uniform green tint of varying depth, but it is probable that at this season the chlorophyll has already undergone a change, and I suspect that the sombre green of some leaves, such as those of the elm, in summer, is partly due to a product of decomposition called "modified chlorophyll," which yields solutions of a much less lively colour than the chlorophyll from which it is formed.

The summer stage is succeeded by that of the autumnal fading of foliage, a change so often observed that it needs no description. With the exaggeration so often employed when coloured objects are referred to, people frequently speak of the multitudinous tints of autumn. In reality, however, these colours, not counting the original green, are only four in number, viz., yellow, brown, red, and purple, and of these the last is a dull inconspicuous colour, while the red occurs so seldom in our native trees as to add but little to the total effect when our woods and plantations appear in their autumnal clothing. It is to the

Passing of the original green into yellow, and from yellow to brown, and the various shades and tints so produced that the effect is in the main due. The yellow colouration is most distinctly seen in the chestnut and the elm. In the latter the gradual tinging of the deep green with yellow produces a peculiarly beautiful effect, and when the change is complete, and the whole tree (to use one of those figurative expressions to which one is so prone) is arrayed in a garb of gold, the appearance when first seen is almost startling. Arrived at this stage the leaves mostly fall, but retain their yellow hue for a short time only, the colour under the influence of air and moisture rapidly becoming brown, though they remain yellow if quickly dried. The oak and the beech keep their leaves after the yellow stage is passed, and the rich reddish brown they then exhibit forms a distinct feature in the autumnal landscape. Young beech trees, as everyone knows, remain clothed with brown leaves during the winter, and only lose them on the unfolding of the fresh leaves in spring.

The leaves of some of our native plants, such as the wild cherry, the currant, the bramble, and various species of sorrel, turn of a lively red in the autumn, but this colouration intensified to a positive scarlet is more distinctly seen in some of the exotics which have been introduced into our gardens, such as the Virginia creeper and the Azalea. A mixture of red and yellow is rarely observed on the same leaf. It is a singular circumstance that the leaves of the oak and sycamore, the young shoots of which are so often tinged of a lively red, do not turn red in fading, but yellow, from which it may be inferred that the process of decay in leaves does not lead back to the same stage at which that of development commenced.

The autumnal purple colouration of leaves is met with in a few native plants, notably the bryony, the privet, and the dogwood. It imparts a dingy hue to the leaves, and is therefore not much noticed. I observed a case of its occurrence last summer, which I had not previously seen mentioned. Passing through a field of corn, which was then nearly ripe, I saw a number of plants by the sides of the path with blades distinctly purple. On closer observation it was evident that in all cases where this colouration occurred the ears of corn had been cut off before ripening, and probably of idle passers-by, those plants which remained uninjured having become yellow as usual. I inferred that it was the injury sustained by the plant, and the arrest of its main function, that of the development of seed, that had led to the formation of some purple substance, not seen during the process of natural decay. I made some experiments on this purple colouring-matter, but all I can say about it is, that it belongs to the same class as the red and yellow colouring-matters of faded leaves. I anticipated the possibility of its being identical with a product of the decomposition of chlorophyll, crystallising in purple needles, which I had discovered in the course of my investigation, but I was disappointed in my expectation.

As regards the nature of the colouring-matters to which the various colours of faded leaves are due, opinions vary. It is generally supposed that they are formed from chlorophyll by some process of decomposition, probably of oxidation, and nothing can be more natural than this supposition. On exposure of the leaf to light and air, after its vital functions have ceased, the green colour due to chlorophyll gradually disappears and is succeeded by red, yellow, or purple. Therefore, it is argued, the respective colouring-matters must be derivatives of chlorophyll. Nevertheless, this view is open to some objection. As regards, in the first place, the red colouring-matter, since no one has succeeded in obtaining it artificially, it must be formed, if a derivative of chlorophyll, by some process not purely chemical. I have, indeed, obtained as one of the products of decomposition of chlorophyll a substance crystallising in red laminae, having a semi-metallic appearance by reflected light, but this substance is entirely distinct from the red colouring-matter of faded leaves.

The latter may easily be procured, at least in an impure state, by extracting the reddened leaves of the garden Azalea or the Virginia creeper with boiling spirits of wine, evaporating the extract at a gentle heat, and treating the residue with water, in which the colouring-matter dissolves. The solution has a fine crimson colour like that of red ink. The colour does not change on the addition of such acids as exert no oxidising action. Nitric acid gradually turns it yellow. By the addition of alkalies, such as ammonia, its colour changes to a yellowish green, and it has then very much the appearance of an alcoholic solution of chlorophyll, but it does not show either before or after the addition of alkali the least indication of absorption-bands, merely a general darkening of the more refrangible end of the spectrum. With lead acetate it gives a grass-green precipitate. These reactions show that the colouring-matter belongs to the same class as that of the rose and red flowers generally; but in the present state of our knowledge regarding this class of substances, it is quite impossible to say whether any two members belonging to the series are identical or not. One thing, however, is certain, viz., that the red colouring-matter of faded leaves is actually formed during the process of decay; it does not pre-exist in the green leaf, though there can be no doubt that leaves which are naturally more or less red, such as those of the copper beech and various species of colum, contain a ready formed red colouring-matter.

As to the yellow colouring-matter of faded leaves, whether it pre-exists in the green leaf or is formed from chlorophyll or some other leaf constituent, it is not so easy to pronounce a decided opinion. This colouring-matter, called by Berzelius *xanthophyll*, is supposed by some to be identical with phylloxanthin, the yellow substance which, according to Fremy and others, always accompanies the chlorophyll of green leaves. Of its properties little is known, and that little I find to be more or less incorrect. It is said to be soluble in alcohol and ether, insoluble in water, to turn green with acids, and to show a peculiar absorption-spectrum different to that of chlorophyll. These statements require correction. It is, in fact, soluble in water, but insoluble in ether; it does not turn green with acids, and the absorption-bands which it shows are due to an admixture of chlorophyll, as a few simple experiments are sufficient to show. Having taken some bright yellow elm leaves I extracted them with boiling spirits of wine, and obtained a greenish yellow liquid, which, after filtration, showed only the dark absorption-band in the red corresponding to band 1. of the chlorophyll spectrum. I evaporated the extract in the water-bath, and during evaporation observed a deposit form on the sides of the dish consisting of green fat-like masses. On adding water to the residue, a portion dissolved, yielding a golden-yellow liquid, while the fat-like masses remained undissolved. After pouring off the liquid and washing the residue with water, the latter was dissolved in hot alcohol, when it gave a yellowish green liquid, which showed all the absorption-bands of chlorophyll distinctly. The golden-yellow watery solution, on the other hand, showed no trace of absorption-bands; merely a general darkening of the blue end of the spectrum. Its colour was evidently due to a yellow colouring-matter contained in it. It gave an abundant yellow precipitate with lead acetate, and a dark green precipitate with ferric chloride. It also contained a considerable quantity of tannin, since it yielded a thick curdy precipitate with gelatine, and an abundant deposit on the addition of a mineral acid. On again evaporating the solution in the water-bath, some decomposition evidently took place, for on adding water to the residue a quantity of matter in the form of brown powder remained undissolved. It is almost certain that it is the same process of decomposition going on in the yellow leaf on exposure to air and moisture that causes the colour to change to brown. I think it probable that the process is one of oxidation, and that it affects the tannin of the leaf or the solution rather than the yellow colouring-matter, for it is well known that

watery solutions of tannin undergo decomposition, accompanied by change of colour from light to dark, on exposure to air, especially when the solutions are hot. This simple experiment shows that the yellow colour of faded elm leaves is due partly, perhaps chiefly, to a yellow colouring-matter soluble in water, partly to a yellowish green substance consisting essentially of chlorophyll. The former is, in my opinion, the true xanthophyll.

In order to gain, if possible, a little more insight into the process whereby the colour of green leaves changes to yellow, I took an alcoholic extract of fresh grass, which was of the usual bright green colour, and exposed it in a window to the action of the sun and air. After some days' exposure it had undergone the well known and frequently described transformation, *i.e.*, the bright green colour had changed to a greenish yellow, and the solution from being opaque even in thin layers had become transparent in consequence of the oxidation of the chlorophyll contained in it. Now this liquid, though not quite so yellow as the alcoholic extract of faded elm leaves, was found closely to resemble the latter. On evaporating over the water-bath and adding water to the residue a yellow liquid was obtained, containing a colouring matter, the reactions of which were similar to those of the substance from elm leaves. No tannin, however, could be detected in the solution, and this may serve to explain the fact that blades of grass, corn, &c., do not ultimately become brown in fading, but remain yellow. The portion of the residue after evaporation left undissolved by water was green and fatty, and its solution in alcohol showed the absorption-bands due to modified chlorophyll.

These experiments leave the question of the nature and mode of formation of xanthophyll undecided. It may be one and the same substance in all leaves, or it may differ according to the source whence it is derived, it may be formed by the oxidation of chlorophyll, or it may pre-exist in the green leaf. I am inclined to think that it exists ready formed in the green leaf, but is not then seen on account of the far greater tinctorial powers of the chlorophyll present at the same time, and that it makes its appearance only when the chlorophyll has been decomposed, the sole trace left by the latter being the slight greenish tinge which all faded yellow leaves show more or less. The varying proportion of xanthophyll contained in green leaves would explain the fact, difficult to understand if we suppose it to be derived from chlorophyll, that some leaves assume a deep yellow colour in fading, while others remain of a pale yellow, and others again are almost colourless when they fall.

I will now conclude, hoping, if I have not communicated anything strikingly new, that I may at least have succeeded in affording the meeting a few moments' amusement.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

Annual Meeting, November 21, 1881.

Mr. E. C. STANFORD, F.C.S., Vice-President, in the Chair.

MR. R. R. TATLOCK, F.C.S., was elected President of the Section in place of Mr. James Maclear, whose term of office had expired. Mr. Coleman and Dr. Dobbie were elected Vice-Presidents, and Mr. Arthur Wingate, Secretary.

MR. COLEMAN, F.I.C., F.C.S., delivered an address on "*Recent Advances in the Production of Cold by Chemical Means.*" He explained the formula of Clausius and Sir Wm. Thomson regulating the performance of all machines for the production of cold, and showed that whatever vapour be used, whether air, ether, sulphurous acid gas, &c., the power required to produce a certain quantity of cold varies in the ratio of the range of cooling or difference between the absolute maximum temperature and the abso-

lute minimum temperature divided by the absolute minimum temperature, thus,—

$$C \frac{t_1 - t_2}{t_1}$$

where C stands for the heat units required to be abstracted; in the one case the energy derived from the coal used in driving the machine being applied directly to compressing the gas by pressure of its own vapour, and in the other case the energy of the coal being passed through the machine which drives the pump. This formula is, however, of little use in practice, without taking into account friction, the density of the vapour used, and its susceptibility to liquefaction. The ammonia machine is generally considered the most powerful, but the limit of its action where no pump is used is the boiling-point of the liquid ammonia, which is about 60° below freezing-point. In some recent ammonia machines, however, a pump is used, and consequently the liquid ammonia really evaporates into a vacuum, its boiling-point being reduced to fully 100° below freezing-point. But in practice these machines begin to lose efficiency long before the brine, being cooled, gets reduced to such low points, the evaporation being less and less rapid as the temperature sinks. For blowing into ships' holds and freezing meat for oceanic traffic, currents of air amounting to from 50,000 to 100,000 cubic feet per hour cooled 100° below freezing-point are required, so that the cooling of air by direct compression and expansion is now being generally preferred when the object is the cooling of air, and not of liquids. Upwards of forty such machines had been designed by the lecturer during the last three years, most of which are now in active use, and capable of freezing or of keeping frozen 200 to 250 tons of meat in a voyage from America or Australia to Great Britain.

NOTICES OF BOOKS.

Experimental Researches into the Properties and Motions of Fluids, with Theoretical Deductions therefrom. By WM. FORD STANLEY. London: E. and F. N. Spon.

WE have here the results of a prolonged series of experiments undertaken originally for the purpose of deciding whether the wave-motions of fluids were really suitable for illustrating those undulations of the ether which are supposed by the accepted theory of light. The author, however, finding that the conditions of the movements of fluids required further investigation, made them his main object, and he has arrived at certain conclusions differing from the generally accepted views on the laws of hydrodynamics. Thus in his second chapter he rejects the theory of *tensile* surfaces for liquids, as set forth by Segner now more than a century ago, and pronounces them instead *extensile*. The meanings which he attaches to these two terms may require explanation. By *tensile* he understands that condition of a surface in which its particles, like those of a stretched drum-skin, have a disposition to draw themselves together—a definition in effect the same as that commonly received. An *extensile* surface, on the other hand, he considers one whose parts have a disposition to separate from each other. He considers that the well-known experiment of a needle floating on the surface of water is in favour of his view. It is commonly considered that the needle does not sink because the particles of the surface of the liquid refuse to admit it between them. Mr. Stanley's interpretation of the phenomenon is as follows:—"If the surface of the water were already under tensile strain, as is now popularly concluded, it would then be clear that the weight of the needle would increase this tension, and unless the special cohesion of the surface were from some undefined cause very great the needle would immediately penetrate it. This would be illustrated by the instance generally offered of a stretched drum-skin ;

if this were stretched very tightly, a very moderate blow with a heavy body would break through it, but if it were loose or flabby it would resist a much greater blow, as the blow must be *plus* the tension present in the first case."

We submit that in this train of reasoning the author does not abide by the definition of "tension" which he has laid down above. If "tension" means a disposition of parts to draw themselves closer together it is clear that the weight of the needle will not increase but diminish this force, and must entirely overcome it before it can rupture the surface and penetrate into the liquid. On the contrary, if the particles of the surface have a disposition to part company—to remove away from each other—the needle ought at once to penetrate.

In the first chapter the author treats of the "construction of atoms forming fluids and other bodies," and lays down the proposition that:—"A simple gas is a fluid composed of atoms or the smallest divisible parts of matter, these atoms being infinitely tough and infinitely elastic bodies endowed with polar attractive forces by which they symmetrically unite." We must here remark that the term "atom" is, in virtue of its very etymology, applied to parts of matter which are indivisible. The author evidently, according to his language, considers matter as active *per se*, and not as merely actuated by external energy. He remarks:—"Every known hard body has an elastic surface; if the atom has such a surface which deflects under pressure by some function of the pressure to the distance of surface impressed, or that the deflection is inversely as the square of the pressure, this deflection commencing upon contact by a quantity of pressure infinitely small. The pressures to the volumes of gases (the relation of the pressures to the volumes of gases, &c.) could as well be accounted for by this means as by any other, without the necessity of supposing the atom to possess propulsive forces or to act where it is not." If we rightly understand this passage it amounts to a rejection of the kinetic theory of gases. The author proceeds:—"There is no physical reason to assume the atom being infinitely hard, as is general: in assuming it infinitely tough and elastic this would equally ensure its permanent durability; or it might possess an infinitely hard nucleus and an infinitely elastic surface, which I think is most probable." In these last lines, therefore, we have the atom presented to us at least ideally divisible, consisting of two layers, and endowed with different properties. We find that on the previous page Mr. Stanley remarks that every known hard body has an elastic surface. Here, therefore, he regards hardness and elasticity as by no means incompatible, though it might be asked why should elasticity be ascribed to the surface only of bodies? Yet a little further we read:—"It is possible that heat may be the entire cause of the surface elasticity of the atom, as just proposed. The atom being without this force infinitely hard and infinitely attractive to other atoms; this is consistent with the known properties of chemical attraction and of heat to separate atoms, that is, to expand matter." We have always, in common with other chemists, supposed that the properties of chemical attraction are not to separate but to unite atoms. We cannot help suggesting that the first chapters, which the author admits are "speculative and even in parts hypothetical" stand in need of reconsideration.

On page 314 the author describes and figures a curious experiment. If a tall narrow glass trough is filled with water, and a pen full of ink is gently applied to the surface of the liquid, the ink, in descending, divides into a double stream, each of which again bifurcates, and so on till we have the resemblance of an inverted tree. We have seen somewhat similar phenomena when a heavier liquid is dropped very gently into one of less specific gravity. Something similar may be witnessed in the action of precipitants upon various solutions. It is possible that this phenomenon may repay investigation. The author's explanation is that the ink, descending slowly by gravitation, "will be found to divide constantly upon the conic resist-

ance which opposes its direct projection." But supposing resistance acting in directions corresponding to the outlines of a cone, we do not see why bifurcation should ensue. We should rather expect that the descending stream would divide into three.

On page 339 we notice a statement which is no longer strictly correct. Water is now known not to be the only body which becomes lighter on solidification. A rod of grain bar tin, coiled up in a flat spiral, will float upon a bath of molten tin and zinc exhibits a similar phenomenon.

OBITUARY.

ROBERT CALVERT CLAPHAM, F.C.S.

MR. CLAPHAM, a well-known chemist, of Earndon House, near Newcastle-upon-Tyne, died at Winchelsea, on the 22nd December, 1881, aged 58 years. He was elected a Member of the Society of Arts in 1874, and he has been since that time a frequent attendant at the meetings and a speaker in the discussions. He was appointed examiner on the Alkali Manufacture in the Technological Examinations of the Society of Arts, when in 1875 this subject was first added to the programme of examinations. When the City and Guilds of London Institute took over the Technological Examinations of the Society, Mr. Clapham continued as Examiner to the new institution. Mr. Clapham was the author of several papers on chemical and chemico-geological subjects in various scientific journals, both alone and with other writers. The first of these was on the "Theory of the Formation of Sulphur in Volcanic Countries," published in the "Transactions of the Tyneside Naturalists' Field Club" (iv., 1858-60). Other papers appeared in the Reports of the British Association, in the *CHEMICAL NEWS*, *Geologist*, and other journals.

CORRESPONDENCE.

THE NEW ALKALOID—HOMO-QUININE.

To the Editor of the Chemical News.

SIR,—The note of Messrs. Wood and Barret (*CHEMICAL NEWS*, vol. xlv., p. 6) does not explain the new alkaloid (homo quinine) lately described by three independent papers, as all who have found it agree that the neutral sulphate re-crystallises unchanged from water, in which it is less soluble than quinine sulphate, and the mother-liquor from the re-crystallisation does not show the presence of quinine when tested by the usual methods.—I am, &c.,

DAVID HOWARD.

Stratford, near London, E., Jan. 9, 1882.

SECONDARY BATTERIES.

To the Editor of the Chemical News.

SIR,—Finding that you have printed Prof. Adams's paper on "Secondary Batteries," we should be obliged if you would kindly inform your readers that the paper may be obtained in pamphlet form from the Secretary of the Science Society, King's College, Strand, W.C., post free, 6d.—I am, &c.,

WALTER G. McMILLAN, Pres.

King's College Science Society,
January 10, 1882.

Use of Salicylic Acid.—M. Pasteur considers that the use of salicylic acid in articles of human consumption is permissible, but that its presence and exact proportion should always be declared.—*Moniteur Scientifique*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 24, December 12, 1881.

Methods of Comparing the Coefficients of Induction.—M. Brillouin.—This paper does not admit of useful abstraction.

Specific Heats of Gases at Elevated Temperatures.—MM. Mallard and Le Chatelier.—The authors have determined the specific heats of carbonic acid, watery vapour, nitrogen, oxygen, carbonic oxide, and hydrogen, at temperatures about 2000°. In case of carbonic acid dissociation began to be manifested about 1800°; watery vapour and carbonic oxide showed no appreciable traces of dissociation, even at temperatures exceeding 2000°. The specific heat of carbonic acid increases with the temperature at least up to 2000°, but the rate of increase diminishes. The specific heats of hydrogen, nitrogen, oxygen, and carbonic oxide are equal to each other at 2000°, as they are at 0°.

Solubility of Barium and Strontium Sulphates in Concentrated Sulphuric Acid.—MM. Varenne and Pauleau.—As regards barium sulphate, whatever are the masses of saline solution brought into play, the coefficient of solubility seems constant. The precipitate obtained from the nitrate is twice as soluble in sulphuric acid as that thrown down from the chloride. The solubility of strontium sulphate is likewise constant, whatever the masses employed. On comparing the coefficients of solubility of the two sulphates it appears that they are approximately proportionate to the equivalents of the bases.

Direct Process of Coppering Cast-Iron, Wrought-Iron, and Steel.—The author dispenses with the use of potassium cyanide, for which he substitutes organic acids or glycerin. The baths serve continuously if fed with copper oxide. The well-known power of alkaline organic solutions to dissolve easily and quickly iron oxides without attacking the metal, renders it easy to clean the objects to be coppered. One method consists in plunging the articles into the bath in contact with zinc wires. The coppering takes place instantly. Or in the vat containing the alkaline organic solution of copper and the objects to be coppered are placed porous vessels filled with soda-lye, in which are plates of zinc connected to the articles to be coppered by means of a thick copper wire. The third method consists in coppering the articles, of whatever thickness, by means of the same baths and a dynamo-electric machine. Nickel, cobalt, antimony, tin, &c., may be deposited upon iron in a corresponding manner.

Pocket Battery with Jointed Elements.—M. Pulvermacher.—A portable apparatus for medical use.

Decomposition of Metallic Formiates in Presence of Water.—J. Riban.—The salts of potassium and sodium are not decomposed at the temperature employed; that of barium is also unaffected. In the salts of the magnesium series an incipient decomposition is traced. In the salts of iron, &c., metallic oxide is set at liberty, and the formic acid is partially decomposed with development of hydrogen, carbonic acid, and traces of carbonic oxide.

No. 25, December 19, 1881.

Observations on the Decomposition of the Metallic Formiates in Presence of Water.—M. Berthelot.—This memoir does not admit of useful abstraction.

The Principle of Surfaces of Separation.—M. Berthelot.—M. Lemoine contends that he had announced this principle prior to M. Berthelot, viz., in 1871. The latter, however, set forth the same principle as early as 1862, in his "Researches on Etherification."

Researches on the Fundamental Laws of Electrodynamics.—P. le Cordier.—This memoir is purely mathematical, and comprises two parts. The object of the first part is to establish the laws, discovered by Ampère, of the action of a closed fixed and permanent linear current upon an element of current, fixed and permanent, which does not form part of it, and to connect therewith the study of all the ponderomotor forces observable upon this same element, and upon a fixed and permanent magnet exterior to the acting system, which may exclude closed, fixed, and permanent currents, fixed and permanent magnets, and terrestrial magnetism. The second part of the memoir contains a brief exposition of the hypotheses of Ampère and Grassman upon the mutual action of two elements of currents.

Lippmann's Method for the Determination of the Ohm.—M. Brillouin.—The author concludes that the method of M. Lippmann measures a quantity absolutely unknown. The phenomena due to the capacity of the wire cannot be generally neglected, but with the particular dimensions indicated in the paper of Dec. 5th, it is possible that the method may furnish an exact determination of the ohm.

History of the Process employed in the Direct Coppering of Cast-Iron.—F. Weil.—The author makes a claim to priority as against M. Val d'Osne.

Diffusion of Solids into Solids.—A. Colson.—The author gives several instances of this phenomenon. Thus if a plate of iron is heated in lamp-black in a reducing atmosphere, not merely the carbon passes into the iron, transforming it successively into steel and cast-iron, but notable quantities of iron become diffused in the charcoal. He concludes that this mutual diffusion only happens in case of bodies which have an affinity for each other.

Combustion-Temperature and the Dissociation of Carbonic Acid and of Watery Vapour.—MM. Mallard and Le Chatelier.—The results are given in the form of tables.

Potassium Chromo-cyanide.—H. Moissan.—The author obtains this compound by the action of potassium cyanide upon a solution of chromium protochloride, or by heating to 100° in a sealed tube chromium ground up with a concentrated solution of potassium cyanide, or by the action of potassium cyanide upon chromous carbonate. Potassium chromocyanide appears in fine yellow crystals. Its specific gravity is 1.71. It has no action upon polarised light. The saturated solution examined with the spectroscope at the thickness of 0.15 metre shows a total absorption of the violet, a less absorption of the blue, and three very visible bands in the green. The salt is anhydrous and permanent in the air at common temperatures. Under the action of an electric current its solution gives chromi-cyanide at the positive pole, and hydrogen and potash at the negative. Its physiological action is similar to that of potassium ferrocyanide, which it closely resembles by the generality of its characters.

Decomposition of Metallic Formiates in Presence of Water: Production of Certain Crystalline Minerals.—J. Riban.—The formiates in question are those of copper, mercury, and silver.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 14, 1881.

The Telephone and Telluric Currents.—M. Dufourcet.—The author has in his court two bars of iron planted in the earth, to each of which is fixed a conductor of coated copper wire terminating in his receiver. These he consults two or three times daily, and they never fail to give notice twelve to fifteen hours in advance of every storm which bursts over the town.

No. 14, 1881.

The Abbé Moigno complains, in an able article, of the treatment which M. Tommasi has recently experienced in

MISCELLANEOUS.

Firth College.—We are glad to learn that the number of students who have entered the Chemical Laboratory of the College this session has been so great that the present accommodation has been quite insufficient. The Council, therefore, decided at their last meeting to erect working benches for sixteen more students. The University of Edinburgh has recently recognised Dr. Carnelley, Professor of Chemistry in Firth College, as a teacher of medicine in Sheffield, whose Lectures on Chemistry and Course of Instruction in Practical Chemistry shall qualify for Graduation in Medicine in that University. The Lectures on Chemistry and Laboratory Practice at Firth College have also been recognised by the Royal College of Surgeons and the Royal College of Physicians.

MEETINGS FOR THE WEEK.

MONDAY, 16th.—London Institution, 5.
— Medical, 8.30.
TUESDAY, 17th.—Institute of Civil Engineers, 8.
— Pathological, 8.30.
— Royal Institution, 3. "The Mechanism of the Senses," Prof. J. G. M'Kendrick.
WEDNESDAY, 18th.—Society of Arts, 8. "The Relation of Botanical Sciences to Ornamental Art," by F. Edward Hume, F.L.S., F.S.A.
— Meteorological 7. Anniversary.
THURSDAY, 19th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Royal Institution, 3. "Corals," Mr. H. N. Mosely.
— Chemical, 8. "Researches into the Chemistry of East Fibres," C. F. Cross and S. J. Bevan. "On Dibenzoyl Aniline and its Isomerides," by A. Higgins. "A New Apparatus for Determination of Melting-points," by C. F. Cross and S. J. Bevan. "Contributions to the History of Certain Compounds," by W. N. Hartley.
FRIDAY, 20th.—Royal Institution, 8. "Comets," Dr. W. Huggins, 9.
SATURDAY, 21st.—Royal Institution, 3. "Louis van Beethoven," by Prof. Pauver.

TO CORRESPONDENTS.

H. Hudson.—If you try the experiment you will find that similar magnetic poles repel, whilst opposite poles attract.

TO CHEMICAL MANUFACTURERS, &c.

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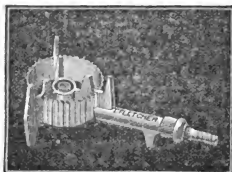
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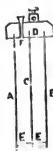
ON A NEW ELECTRICAL STORAGE BATTERY.*

(SUPPLEMENTARY NOTE.)

By HENRY SUTTON.

THE new cell consists of a flat copper case, same shape as a Grove's cell; it has a lid of paraffined wood, from which hangs a plate of lead amalgamated with mercury, the lower part of lead plate being held in a groove in a slip of paraffined wood resting on bottom of copper case; through the lid a hole is bored for introduction of solution, which consists of a solution of cupric sulphate, to which is added one-twelfth of hydric sulphate; the presence of this free sulphuric acid improves the cell at once.

The following sectional sketch shows the arrangement:—



A B, the outer flat copper case.

C, plate of amalgamated lead held in grooves in cap D and slip E. F shows the hole in cap through which the solution is introduced, and by the introduction of a glass tube through this hole the state of the charge is seen by observing the colour; the interior surface of the case forms the negative electrode, and the amalgamated lead the positive.

ON THE VARIATION OF THE ELECTRIC CONDUCTIVITY OF GLASS WITH TEMPERATURE, DENSITY, AND CHEMICAL COMPOSITION.†

By THOMAS GRAY, B.Sc., F.R.S.E.

In this paper the results of the continuation of a series of experiments, some preliminary results of which were published in the *Phil. Mag.* for October, 1880, are given. The experiments were performed in the Physical Laboratory of the Imperial College of Engineering, Tokio, Japan.

In the preliminary experiments it was found that the conductivity of glass increased with the temperature, following a similar law to that found to hold for other highly insulating substances. It was also found that the effect of successive heatings and coolings was to diminish the conductivity. Further experiments on this subject show that, although the diminution of conductivity here referred to sometimes occurs, it does not always occur, and does not seem to do so when the glass is newly manufactured. Reference is made to preliminary experiments on the effect

of time on the electric conductivity of glass, the results of which indicate an increase in conductivity with time.

The subject of the main part of the paper is an account of experiments on the relation between the electric conductivity of glass and its density and chemical composition. A large number of specimens of fine glass were examined, but, as was to be expected in this case, no marked connexion between electrical quality and density could be observed. It was found, however, on analysing a few specimens, that the composition of those which had a high conductivity differed considerably from that required to form an exact chemical compound, whilst those which had a low conductivity had a composition agreeing more or less closely with that required for a trisilicate of potash and lime or a mixture of potash, lime, and soda-lime trisilicates.

A few specimens of lead or flint glass were examined in the same way, and in this case a very marked connexion between electric conductivity and density was observed. This result was, however, no doubt due to the fact that the density of this kind of glass gives an indication of its chemical composition. In all the specimens examined it was found that the higher the density the lower the conductivity. The highest density reached, however, was that in the case of a Thomson's electrometer jar, which had a density of 3.172. On examining these specimens for chemical composition it was found that the electrometer jar contained almost exactly the proper amount of lead and potash to form a trisilicate of potash and lead. It appears likely, therefore, that the electric conductivity of glass is lowest when it is an exact chemical compound. It will be interesting to learn from future experiments if still more dense glass has a higher conductivity, and if the conductivity passes a minimum at the point where the pure silicate is reached.

The author has to express his great obligation to his colleague, Dr. Edward Divers, in whose laboratory and under whose superintendence the chemical analyses of the specimens of glass were made.

QUANTITATIVE DETERMINATION OF UREA BY ALKALINE HYPOCHLORITES AND HYPOBROMITES.

By THEO. G. WORMLEY, M.D.,

Professor of Chemistry in the University of Pennsylvania.

THE determination of the amount of urea present in the urine by the volume of nitrogen evolved under its decomposition by sodium hypochlorite was first proposed by Davy (*Phil. Mag.*, 1854, p. 385). According to his observations, the quantity of nitrogen evolved corresponded very closely to the calculated amount present in the urea. But according to the observations of M. Lecomte (*Chem. Gaz.*, 1858, 431), with a different form of apparatus, under the action of this reagent only about 92 per cent of the nitrogen is evolved.

Messrs. Russell and West proposed to substitute for the hypochlorite an alkaline solution of sodium hypobromite, and advised a special form of apparatus for the application of the test (*Your. Chem. Soc.*, Aug. 1874, and *Am. Jour. Med. Sci.*, April, 1875, p. 531). These observers, however, obtained only about 94 per cent of the total nitrogen.

Under the action of either of these reagents, as is well known, the urea is resolved into carbon dioxide, water, and free nitrogen, thus:—



Theoretically, therefore, the whole of the nitrogen should be evolved, but it is generally admitted that in practice this is not the case. According to at least one observer, this loss is due to a portion of the nitrogen being retained as a cyanate; whilst according to another it is retained as a nitrate.

* A Paper read before the Royal Society, January 12, 1882.

† Abstract of a Paper read before the Royal Society, Jan. 12, 1882.

To remedy this defect, M. Mehu advised to mix either glucose or cane-sugar with the urine before adding the hypobromite, when the whole of the nitrogen would be set free (*Comptes Rendus*, 1879, 175). But, according to M. Esbach (*Ibid.*, 477), and also to M. Jay (*Bull. Soc. Chim.*, 1880, 105), a solution of glucose alone evolves some gas under the action of the reagent. Again, M. Fauconner obtained in the presence of glucose, from a given quantity of urea, the theoretical amount of nitrogen; whilst in the presence of cane-sugar he obtained only 94 per cent of the total nitrogen (*Ibid.*, 102).

According to my own experiments, when a solution either of cane-sugar or of glucose is mixed, at least in certain proportions, with the hypobromite reagent, without the presence of urea, the temperature of the mixture increases and its yellow colour is gradually discharged, but no gas is evolved. When 1 grm. of cane-sugar in 5 c.c. water was added to 10 c.c. of the reagent (prepared as stated hereafter) at 21° C. (70° F.), the mixture at the end of twenty-five minutes acquired a temperature of 30° C. (86° F.), after which the temperature slowly fell.

In a similar experiment with glucose, the temperature increased from 21° C. (69.8° F.) to 35.5° C. (96° F.) in ten minutes, which was the maximum reached. It was also observed that the presence of large excess of glucose entirely prevented the decomposition of urea by the hypobromite reagent.

For the purpose of examining the accuracy of this test for urea, without the presence of cane-sugar or glucose, the form of apparatus, at least in principle, advised by R. Apjohn (*Chem. News*, vol. xxi., p. 37), was employed. This consists of a wide-mouthed bottle in which is placed the reagent, and also a small test-tube, for containing the urea solution, of about 1 c.c. capacity and of such length as to stand inclined in the bottle. The mouth of the bottle is closed with a rubber stopper carrying a glass tube, by which it is connected by rubber tubing to a graduated burette divided into one-tenth c.c. and suspended in a long cylinder of water from an adjustable arm.

The urea solution is placed in the small tube within the charged bottle, the apparatus closed, and when there is no longer any change in the height of the column of liquid within the graduated tube, this is so adjusted that the surface of the contained liquid exactly coincides with that in the cylinder. This point, the temperature, and in exact experiments the barometric pressure, being noted, the urea solution is mixed with the reagent by inclining the bottle and gently shaking the mixture. As the evolved nitrogen collects in the graduated tube, the latter is gradually raised to relieve the contained gas from the increased pressure. When the evolution of gas has entirely ceased and there is no longer any change in the volume of gas, the tube is finally adjusted and the exact volume noted. The reagent employed was prepared, as first advised by Messrs. Russell and West, by dissolving 700 grains caustic soda in 250 c.c. water, and adding to the cooled mixture 25 c.c. bromine. In applying the reagent it was diluted with a volume and a half of pure water.

With this arrangement a series of experiments was performed employing 1 c.c. of a standard solution of pure urea varying in strength from one to six per cent, variously diluted, and added to varying quantities of the reagent. These experiments gave different results, in some only about 90 per cent, and even less, of the nitrogen being evolved, while in others a larger proportion was obtained, and in still others the whole of the nitrogen was set free. It was finally observed that under certain conditions the whole of the nitrogen is uniformly eliminated. These conditions are:—

1. The reagent should be freshly prepared.
2. The urea solution should be wholly added to the reagent, none of the latter being allowed to mix with the urea solution in the containing tube.
3. The amount of urea operated upon should not exceed one part to about twelve hundred parts of the diluted reagent.

Moreover, the diluted urea solution should be added in small portions at a time to the reagent, thoroughly mixed, and the effervescence allowed to cease before any further addition of urea. So, also, it would appear, at least when comparatively large quantities of urea are present, that the surrounding temperature should not be less than about 20° C. (68° F.).

In the practical application of the test, if a 2 per cent solution of urea is under examination, 1 c.c. of the solution, diluted with from 5 to 10 c.c. water, is placed in the containing tube, and the mixing bottle charged with 10 c.c. of the reagent diluted with 15 c.c. water; whereas, for 1 c.c. of a four per cent. solution of urea, similarly diluted, not less than about 50 c.c. of the diluted reagent should be employed.

In a final series of experiments, in which the above conditions were observed, the temperature being noted to one-tenth of a degree, and the results reduced to the standard temperature (50° C.) and barometric pressure (760 m.m.), the following average results were obtained:—

| Urea employed. | Nitrogen evolved= |
|-----------------|-------------------|
| 10 milligrammes | 9.98 m.grm. urea. |
| 20 " | 20.07 " |
| 30 " | 29.95 " |
| 40 " | 39.88 " |

In these experiments it was assumed that 1 gramme of urea contains 372 c.c. of nitrogen, measured at 0° C. and 760 m.m. barometric pressure; or, that each c.c. of nitrogen evolved, measured under the conditions stated, represented 0.002688 gramme urea.

During these investigations it was observed, in cases in which the whole of the nitrogen was not evolved, that so long as the conditions remained the same, the relative proportion of the nitrogen eliminated was pretty uniform. Hence, if the volume of nitrogen evolved from a known quantity of urea under certain conditions, or by a given form of apparatus, be determined, the result may be taken as the basis for the determination of the urea in the urine with sufficient accuracy for clinical purposes.—*American Journal of the Medical Sciences.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING DECEMBER 31ST, 1881.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOOT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE the PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

January 3rd, 1882.

SIR,—In this, our twelfth monthly report, we lay before you the results of our analyses of the 180 samples of water collected by us during the month of December, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 180 samples, one was recorded as "slightly turbid," and 15 as "very slightly turbid." The remaining 164 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from December 1st to December 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright. Of the 26 samples from the mains of the East London Company, the whole, excepting one recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, the whole, excepting one recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, the whole, excepting one recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, the whole, excepting one recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the Grand Junction Company, 4 were found to be "very slightly turbid," the remainder being well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, one was recorded as "slightly turbid," seven as "very slightly turbid," and eighteen as well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

As was to be expected from the observations of many previous years, the amount of organic carbon in the water, together with the degree of its colour, is appreciably in excess of that present during the Summer and Autumn. There is not, however, any increase in the proportion of nitrate and chlorides, or any decrease in the proportion of dissolved oxygen.

We are at present engaged in preparing a Report, in which we shall endeavour to place before you as a whole the results of the analyses made by us during the past year.

We have the honour to remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODING,
C. MEYMOTT TIDY.

RESEARCHES ON THE COMPLEX INORGANIC ACIDS.*

By WOLCOTT GIBBS, M.D.,
Rumford Professor in Harvard University.

PHOSPHO-MOLYBDATE.

THE application of molybdic oxide to the separation and estimation of phosphoric acid has given a special interest to the phospho-molybdates, and they have accordingly been studied more or less completely by several chemists. The most thorough investigations which we possess are those of Debray,[†] Ramsberg,[‡] and Finkner,[§] but particular salts have been examined by others, and these will be noticed under the appropriate special headings.

Phospho-molybdates appear to be formed whenever phosphoric acid or a soluble phosphate is brought in solution with a molybdate, the presence of a free acid not being essential. They are also formed when phosphates and molybdates are fused together, when molybdates insoluble in water are dissolved in phosphoric acid, when molybdic oxide is digested with an alkaline phosphate,

and when insoluble phosphates and molybdates are treated together with a dilute acid. As a class they are better defined and more easy to obtain pure than the phosphotungstates, which in many respects they closely resemble. When phospho-molybdates of fixed alkaline bases are heated they at first give off water of crystallisation, and by careful heating may be obtained anhydrous. In some cases, however, molybdic oxide is volatilised even from salts containing fixed alkaline bases. I did not succeed in obtaining well defined pyro-phospho-molybdates or pyro-phospho-tungstates, though of course the residues of the ignition of the acid salts may be regarded as such. When a phospho-molybdate is dissolved in ammonia-water and a current of sulphydric acid gas is passed into the hot solution, sulpho-molybdates are formed in large quantity. This reaction distinguishes the phospho-molybdates from the phospho-tungstates, which are not decomposed under the same circumstances.

Analytical Methods.—The determination of the sum of the percentages of molybdic and phosphoric oxides was usually effected, as in the case of the phospho-tungstates, by precipitating the two oxides together by mercurous nitrate, with addition of mercuric oxide to neutralise the free nitric acid. It is best to precipitate from a boiling solution, and to boil for a short time after adding mercuric oxide. This last must always be in small excess. On account of the volatility of molybdic tetroxide, it is not possible to determine directly the sum of the weights of the two oxides by simple ignition, but the difficulty may be readily overcome by the following process:—The filter with the mercurous salts is to be cautiously heated in a platinum crucible properly inclined to the vertical axis of the flame until the filter is completely carbonised. On then regulating the heat and the supply of air, the carbon may be readily burned off, leaving a mass of mercurous salts mixed with more or less mercuric oxide, no weighable amount of molybdic tetroxide being lost. An accurately weighed quantity of anhydrous normal sodic tungstate in fine powder is then to be added, and the contents of the crucible carefully mixed together with a stout platinum wire previously weighed with the crucible itself. The whole is to be heated at first by radiation from a small iron dish, and afterwards directly, until a clear white fused mass is obtained. A second ignition and second weighing will determine whether every trace of mercury has been expelled. It is almost needless to remark that all these operations must be conducted under a flue with a good draught. This process gives excellent results, and is much less tedious than would perhaps be supposed.

After the estimation of the phosphoric oxide, the molybdic tetroxide is best determined by difference from the sum of the weights of the two oxides found as above. No really good general method for the quantitative separation and estimation of molybdic oxide has yet been given, at least no one which is sufficiently accurate to serve as a check upon the method above described. The ammonium salts of this series are most simply analysed by igniting them directly with sodic tungstate, when the loss of weight corresponds to the sum of the water and ammonia.

As in the case of the phospho-tungstates, the quantitative determination of the phosphoric oxide is a matter of considerable difficulty. The method of separation by means of magnesia-mixture has been carefully studied by Dr. Gooch, to whose paper I have already referred.* Dr. Gooch found it necessary to precipitate the ammonio-magnesian phosphate a second time, a single precipitation giving an error amounting sometimes to 6 or 7 per cent of the phosphoric acid present. After re-solution and precipitation by ammonia, the mean error amounted to only 0.65 per cent, which makes an almost insensible correction when the quantity of phosphoric oxide is small. In a few instances I have applied this correction after a double precipitation, but I prefer to employ the following method, which gives an almost perfect separation from molybdic

* *Proceedings of the American Academy of Arts and Sciences.*
Communicated by the Author.

† *Bull. Soc. Chim.*, 2, 40.

‡ *Berichte der Deutsch. Chem. Gesell.*, 10, 1776.

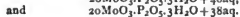
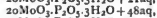
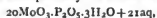
§ *Ibid.*, 11, 1698.

* *Proceedings of American Academy*, 13, 33.

teroxide. The phosphoric oxide is first precipitated from a hot solution as ammonio-magnesian phosphate, the supernatant liquid after complete subsidence carefully decanted upon an asbestos filter, the precipitate washed with magnesia-mixture and ammonia, then re-dissolved in the least possible quantity of hot dilute chlorhydric acid and re-precipitated with ammonia. After complete subsidence and decantation, the precipitate is boiled with successive portions of a solution of ammoniac sulphide. A more or less dark orange red solution of ammoniac sulpho-molybdate is always obtained at first, but after two or three repetitions of the process the ammoniac sulphide added remains colourless on heating. The ammonio-magnesian phosphate is then filtered upon the asbestos filter already employed. In place of this method I have sometimes employed the following modification, which gives, I think, equally good results. After the first precipitation the phosphate is to be re-dissolved, and the hot solution precipitated at once by ammoniac sulphide in excess. The precipitated phosphate is then to be boiled two or three times with ammoniac sulphide as above. Whatever inaccuracy is inherent in this method depends, in my judgment, upon the fact that, as Dr. Gooch has shown, the determination of phosphoric acid by means of magnesia is, under the most favourable circumstances, a less accurate process than has been supposed.

The determination of ammonia and the alkalis was effected by the methods already described in the case of the phospho-tungstates. Water must be estimated by ignition with sodic tungstate, as there is often volatilisation of molybdic tetroxide when a phospho-molybdate is ignited at a temperature sufficient to expel its water. The analyses require great care and no small amount of practice to ensure good results. As in the case of the phospho-tungstates, the alkaline bases are best determined by difference.

Twenty-four Atom Series.—Phospho-molybdic acid. The acid of this series was first obtained by Debray, who prepared it by boiling ammoniac phospho-molybdate with nitro-muriatic acid, and allowing the solution to evaporate spontaneously. I find that this is a good method of obtaining the acid, but the following details should be observed. The bright yellow ammoniac phospho-molybdate should be first dried, and then heated with a large excess of strong aqua regia in a casserole over an iron capsule to serve as a radiator. In this manner the decomposition proceeds very regularly and without successions. When it becomes necessary to add fresh acid, the supernatant liquid should be allowed to settle completely and then be poured off carefully. Fresh acid may then be added, and the process, which is at best a slow one, continued. When the ammonium salt has disappeared, the liquid is to be evaporated until the excess of nitric and chlorhydric acids has been expelled. On standing, large bright yellow octahedral crystals are obtained from the very concentrated solution. These may be re-dissolved and recrystallised, but there is always some loss in the process of purification, because solution in water produces more or less decomposition of the acid, with formation of a pale greenish white crystalline body. This substance passes very readily through a filter, and the solution of the acid must be allowed to settle completely before the clear supernatant liquid is brought upon the filter. Debray obtained three different hydrates of phospho-molybdic acid, to which he gave respectively the formulæ—

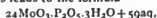


Unfortunately he has not given either the methods or the complete results of his analyses. In the first hydrate he found 13.30 per cent, in the second 23.40 per cent, and in the third 19.60 per cent of water.

I obtained the acid only in transparent octahedral crystals which had a bright yellow colour. Of these crystals, dried by pressure with woollen paper :—

0.9945 grm. lost by ignition with WO_3Na_2 0.2362 grm.
= 23.75 per cent water.
1.4588 grm. gave 0.0713 grm. $\text{P}_2\text{O}_5\text{Mg}_2$ = 3.12 per cent P_2O_5 .

The analysis leads to the formulæ—



which requires :—

| | | Calc. | Found. |
|-------------------------------|----|-------|--------|
| 24MoO ₃ | .. | 3456 | 73.31 |
| P ₂ O ₅ | .. | 142 | 3.01 |
| 63H ₂ O | .. | 1116 | 23.68 |
| | | 4714 | 100.00 |

The phosphoric oxide was determined by double precipitation and treatment with ammoniac sulphide. The molybdic oxide was estimated by difference. The crystallised acid effloresces so readily that the precise determination of the water is difficult. In a portion of the crystals which had effloresced in a very marked degree—

0.973 grm. lost on ignition with WO_3Na_2 0.1760 grm.
= 17.82 per cent water.

2.2472 grm. gave 0.1163 grm. $\text{P}_2\text{O}_5\text{Mg}_2$ = 3.31 per cent P_2O_5 .

The ratio of the molybdic to the phosphoric oxide is, in this analysis, also 24 : 1 ; and, if we compute the results of both analyses for an anhydrous compound of the two oxides, we find—

| | | Calc. | | |
|-------------------------------|----|-------|--------|--------|
| 24MoO ₃ | .. | 3456 | 96.06 | 95.91 |
| P ₂ O ₅ | .. | 142 | 3.94 | 4.06 |
| | | 3598 | 100.00 | 100.00 |

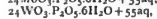
The analyses leave, I think, no reasonable doubt as to the ratio of the two oxides. Phospho-molybdic acid therefore corresponds in composition with phospho-tungstic acid, the ratio of the two oxides being 24 : 1, as given by Finkner,* and not 20 : 1, as stated by Debray. With respect, however, to the number of atoms of water in the crystallised octahedral hydrate, I may remark that, while the analysis agrees best with the formula given,—



it is much more probable that the acid really contains an atom less of water, and that its formula, apart from the question of basicity, is—



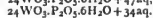
like



already described. This formula requires 23.38 per cent water, instead of 23.75 per cent, as found. Debray found 23.40 per cent. As already stated, the crystals analysed were dried by pressure with woollen paper after draining off a syrupy mother-liquor, and may therefore not have been perfectly free from extraneous water. Finally, the analyses of Finkner led also to the formula with 61 atoms of water, and I shall adopt this as the definite constitution of the octahedral hydrate. Finkner's work has not yet been published in detail ; but, from the abstract which he has given, it clearly appears that we owe to him the establishment of the true constitution of the only phospho-molybdic acid yet obtained. As already mentioned, there are two other hydrates of phospho-tungstic acid having respectively the formulæ—



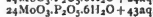
and



The two hydrates of phospho-molybdic acid described by Debray would correspond to the formulæ—



and—



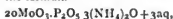
if we suppose them, as is most probable, to belong to the 24-atom series. The first formula requires 13.05 per cent,

* Loc. cit.

the second 19.66 per cent water. Debray found 13.09 per cent and 19.60 per cent. Finkener obtained still another hydrate, containing about 32 atoms of water, basic water included.

Phospho-molybdic acid dissolves very readily in water, forming a colourless liquid which has a strong acid reaction. As already stated, the solution is always accompanied by a slight decomposition, with formation of a very pale greenish white crystalline substance. A precisely similar decomposition is observed in the solution of the corresponding phospho-tungstic acid. The crystals lose all their water when slightly ignited. According to Finkener, three atoms of water remain at 140° C. The solution readily expels carbonic dioxide from the alkaline carbonates. The question of the basicity of the acid will be discussed farther on.

24:3 Ammonic Phospho-molybdate.—The constitution of the beautiful yellow salt which is formed when an excess of a mineral acid is added to a solution containing molybdic and phosphoric oxides and a salt of ammonium, has long been in dispute. The analyses of Svanberg and Struve,* Nuttinger,† Sunnenschein,‡ Lipowitz,§ and Seligsohn,|| gave results which differed very sensibly from each other, according to the method of analysis employed. Debray gave the formula—



but without the details of his analysis. More recently the subject has been examined with great care by Finkener,¶ who has arrived at the conclusion that, though the percentages of water and ammonia may vary within wide limits, the ratio of the molybdic and phosphoric oxides is always as 24:1.

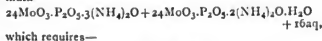
With respect to the preparation and properties of the yellow ammonium salt, I have little to add to what has been done by these chemists. I repeatedly prepared the salt for analysis, usually by mixing solutions of ammonic molybdate—7:3 salt—and phosphate, adding nitric acid in excess to the solution, and boiling. When the mixed solution is boiled for a short time, the precipitation of the yellow salt is complete after standing until the liquid becomes cold. In the publication of this result, which is important in analysis, I have been anticipated by Atterberg**; but I propose in another paper to give the results of my work on the quantitative determination of phosphoric acid, and will then give ample details.

As regards the composition of the yellow phospho-molybdates of ammonium, my results do not agree with those of Finkener, as I think I have evidence that, as in the case of the phospho-tungstates, there are series of phospho-molybdates in which the ratio of the molybdic to the phosphoric oxide is an 20:1, as 22:1, and as 24:1. In one preparation—

- 1. 1492 grm. lost on ignition with WO_3Na_2 0.0827 grm. NH_3 and H_2O = 7.20 per cent.
- 2. 5905 grm. lost on ignition with WO_3Na_2 0.0432 grm. NH_3 and H_2O = 7.31 per cent.
- 3. 17158 grm. gave 0.1027 grm. $\text{P}_2\text{O}_5\text{Mg}_2$ = 3.83 per cent P_2O_5 .
- 4. 9806 grm. gave 0.0567 grm. $\text{P}_2\text{O}_5\text{Mg}_2$ = 3.70 per cent P_2O_5 .
- 5. 18903 grm. gave 0.1321 grm. NH_4Cl = 3.20 per cent $(\text{NH}_4)_2\text{O}$.

In these analyses the first determination of the phosphoric oxide was made by double precipitation only, without subsequent treatment with ammonic sulphide; but in the second this reagent was employed in the manner above described. The ratio of MoO_3 to P_2O_5 is almost precisely

24:1, and the analyses correspond closely with the formula—



which requires—

| | Calc. | Mean. | | |
|--------------------------------|-------|--------|--------|------|
| 48 MoO_3 .. | 6912 | 89.05 | 89.00 | — |
| 2 P_2O_5 .. | 284 | 3.66 | 3.75 | 3.70 |
| 5 $(\text{NH}_4)_2\text{O}$.. | 263 | 3.35 | 3.39 | 3.39 |
| 17 H_2O .. | 306 | 3.94 | 3.86 | 3.81 |
| | 7762 | 100.00 | 100.00 | 3.92 |

Acid salts of similar type occur frequently in the class of phospho-molybdates, as in that of phospho-tungstates.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

December 5, 1881.

MR. ROBERT R. TATLOCK, President, in the Chair.

DR. WALLACE delivered his opening address, "The Dissociation of Chemical Compounds," illustrating his subject by numerous experiments:—

There are in chemistry two great and leading methods of research which have contributed equally to the advancement of our knowledge of the relations of the various elements to one another. One of them is called analysis, or decomposition, or dissociation—although the last-named term expresses analysis in a somewhat restricted sense; the other is denominated synthesis, or combination. It is to the first of these methods of enquiry that I shall ask you to follow me in the remarks I shall address to you, and chiefly in the more limited sense implied in the term dissociation.

The word analysis in chemistry signifies a separation or splitting-up of a body into its component parts, such separated parts differing from each other and from the original body from which they were taken. This definition of analysis at once distinguishes chemistry from physics in the restricted application of the word. If we take a piece of marble, we can examine it either physically or chemically. In the first case we may estimate the exact size of the stone, its absolute weight in pounds, grains, or grains, as the case may be; its weight as compared with that of an equal bulk of water, or specific gravity, as it is usually termed; its relations to light, heat, and electricity; its comparative hardness, and many other qualities. We may also, by mechanical means, break the lump in pieces and reduce it to powder; but each minute fragment will still be a piece of marble, unchanged in all its properties. But how different is a chemical examination! The application of an acid at once discloses the fact that the mineral contains a gas, and also a body which dissolves in the acid, forming a clear solution, from which it may afterwards be obtained by appropriate means. This is analysis or decomposition. The same mineral—which is simply one of the many forms of limestone—if exposed to a full red-heat in a furnace, is separated into its constituents; lime remains behind, while carbonic anhydride—or, as it is commonly called, carbonic acid gas, escapes with the products of the combustion of the coal, although it can readily, by appropriate means, be collected and its properties examined. This is dissociation, or the separation of a compound body into its constituents, without the intervention of any other chemical agent. By various methods—some extremely

* *Journal für Praktische Chemie*, 44, 291.

† *Pharmaceut. Vierteljahresschrift*, 4, 549.

‡ *Journ. f. Prakt. Chemie*, 53, 342.

§ *Poggendorff's Annalen*, 109, 135.

|| *Journ. f. Prakt. Chemie*, 57, 470.

** *Loc. cit.*

¶ *Berichte der Deutsch. Chem. Gesellschaft*, 14, 1217.

simple, others highly complex—all substances, animal, vegetable, and mineral, within our reach, have been analysed or decomposed, or dissociated, until we have arrived at a number of bodies which we call elements—about 65 in number—which we have never yet been able to tear asunder into any simpler form of matter. Of these the greater number are metals, while a comparatively small proportion—about one-fifth of the whole—are either gaseous or possess properties of an opposite character to those of the metals. Among the latter, I may mention sulphur, phosphorus, iodine, bromine, and carbon. The distinction between the metals and non-metallic elements is not, however, so precise and absolute as might at first be supposed; phosphorus is closely allied to the metal arsenic, the metal chlorium forms compounds like those of sulphur, and there are many other singular analogies. It was long accepted as an axiom in chemistry that the gas hydrogen was a metal, or acted the part of one; but it has, within the last few years, actually been condensed by intense pressure and extreme cold into a liquid, and even into a solid metal. Of this, however, I shall speak further on.

The forces by which bodies may be dissociated are various, but by far the most important is heat. In many cases compounds appear to have their constituents grouped together so loosely that the most insignificant application of force suffices to break them up. Thus the compounds usually called chloride and iodide of nitrogen (consisting of ammonia, the hydrogen of which is more or less completely replaced by chlorine or iodine) explode with violence on being touched with a feather, or by mere agitation of the air by which they are surrounded. The green hydrated oxide of copper holds its combined water so feebly that, on heating to the boiling-point, even below water, it is separated, and the black anhydrous oxide is produced. A weak solution of the crystallised chloride of cobalt, on being heated to boiling in a sealed tube one-third full, changes from the hydrated to the anhydrous condition, the separation of the water of hydration being made apparent to the eye by the liquid changing from pink to blue. Many ammoniacal salts become dissociated to a certain extent on their solutions being heated. The oxides of mercury are readily decomposed at a low red-heat (600° to 700° F.), and those of silver, gold, and platinum all give off their oxygen, leaving the metals in a pure condition, on exposure to a moderate heat. In other cases the decomposition is only partial, as when the black or binoxide of manganese is converted into the lower brown oxide, when chromic acid gives off half its oxygen, and becomes the green oxide of chromium, when iron pyrites gives off part of its sulphur; and many other cases of a similar nature.

Heat is only one of the many forms of force by which compound bodies are affected. Light has a distinct power of decomposing many chemical compounds. The salts of silver are particularly sensitive to light, and the art of photography depends entirely upon the effect of light on silver salts and other compound bodies. Vegetable colours are also readily changed by light, but by far the most important function played by light in decomposing compound bodies is displayed in the phenomena of plant life, in which carbonic anhydride, water, and ammonia are decomposed, and their elements re-arranged so as to give rise to an infinite multitude of new combinations, while oxygen gas is freely given off.

Electricity is a potent agent of dissociation, and is frequently used by the chemist, especially for the separation of metals from their solutions. One of the most familiar illustrations of the action of voltaic electricity upon chemical compounds is the decomposition of water, in which the two gases of which it is composed—oxygen and hydrogen—pass off from the two electrodes or terminals of the wires of the battery. A convenient form of the arrangement, as a lecture illustration, is that in which the gases, as they stream off, are collected in graduated tubes, so that the analysis is really quantitative. Although it is

wandering a little from our subject, it may be interesting to consider for a moment how it is that the gases appear at the two poles, which may be many inches apart. If we take a molecule of water, composed of one atom of oxygen and two atoms of hydrogen, and suppose this molecule to occupy a position in close contact with one of the poles, we can understand how one of the gases, say the oxygen, is evolved at that pole; but how does the hydrogen travel to the other pole? The answer to this is, that it does not travel at all, but unites with the oxygen of the nearest molecule of water in the direction of the current, which in turn gives up its hydrogen to the next molecule, and so on until the other pole is reached and the gas is disengaged. We have, as it were, a polarisation of the water, by virtue of which we may conceive that a series of molecules are distorted so as to have their oxygen pointing in one direction and their hydrogen in the other, the ultimate effect being as I have stated.

I may make another digression, but only for a moment, to ask your attention to the terms atom and molecule. With regard to atoms, we know the relative weight of these, and, in the case of gases, their relative dimensions, but of their actual weight or size we are, and must ever remain, in ignorance. It is true that in the case of certain elementary gases, mathematicians have made estimates of their probable size (for example, it has been calculated that the atom of hydrogen does not exceed one five-millionth of an inch in diameter); but even in such estimates as these we cannot tell whether we are dealing with ultimate atoms or molecules composed of an aggregation of atoms. It is certain that some gases, such as chlorine and iodine vapour, are composed of molecules or grouped atoms, since these can be dissociated by heat, the gases expanding in volume when the dissociation takes place. Neither can we tell whether elements, in combining together, unite atom to atom or molecule to molecule. In water, one of the simplest of chemical compounds, since it contains only two elements, we have oxygen and hydrogen in the proportion of one atom of the former to two atoms of the latter. But we cannot tell how these atoms are grouped. We can represent it with an atom of oxygen in the centre with one of hydrogen on each side, or with one of oxygen above and a double atom of hydrogen below; but these are not at all likely to be correct. It is almost absolutely certain that the molecule of water has a geometric or solid figure, which could not be made up of less than six atoms, and probably is much more complex. A system of representations of compound bodies by diagrams, called *graphic formulae*, have for some years been employed by some of our leading chemists, and are said to be useful in teaching the science. To my mind they form a stumbling-block rather than an assistance to the student, who is constantly confronted with representations of arrangements which cannot by any possibility exist in nature.

Other examples of the dissociation of compounds by electrical agency might be mentioned. Hydrochloric acid is easily decomposed, hydrogen gas being given off at one pole and chlorine at the other; but the chlorine, being soluble in the liquid hydrochloric acid to some extent, is not immediately evolved in the gaseous state. Its presence may, however, be evidenced by its bleaching action upon vegetable dyes—indigo, for example; being at once decolourised by the electrolysed hydrochloric acid. In like manner hydriodic acid is decomposed by the electrical current—or, what amounts to the same thing, a solution of potassium iodide acidulated with hydrochloric acid. On passing the current, iodine is immediately set free, and may be distinguishing by forming a blue compound with starch, while hydrogen is disengaged at the opposite pole.

In the practical arts the deposition of metals has now become an industry of enormous dimensions. The manufacture of electro-plate alone engages thousands of operatives in Birmingham, Sheffield, and other towns; and, among other branches of the art, I may mention electro-gilding, and the deposition of copper, brass, and nickel—

the last a comparatively new industry, which is rapidly assuming large proportions. In these cases the battery has been replaced by the steam-engine, the mechanical force of which is converted into the electric current by the magneto-electric machine, where permanent magnets are employed, or the dynamo machine, in which electro-magnets are used.

The fact of metals being constantly set free at one pole of a battery, while what we call, for want of a better name, non-metallic elements, appeared at the other, led many years ago to the introduction of the term electro-positive elements for the metals, including hydrogen, and electro-negative for the opposite group, including chlorine, iodine, bromine, fluorine, oxygen, sulphur, and so on. These terms, however useful in their time, are scarcely, if at all, used by chemists at the present day.

To return to the action of heat in its action upon chemical compounds, I have now to carry you a little further. We have seen that many compounds are readily decomposed; but there are others which require the highest temperature at our command for their decomposition. Until very recently water was supposed to be incapable of being separated into its elements by heat alone. By an ingenious contrivance Sir William Grove succeeded in effecting the re-solution of this compound, and in this way:—In a flask water was made to boil, and in a tube which received the steam a succession of electric sparks were passed from a Ruhmkorff coil, and the steam further on was condensed, while the gases formed by the dissociation of the watery vapour by the intense heat of the electric spark were carried forward by an aspirator or Sprengel pump into an appropriate receiver. In this case the gases, once separated, were pushed on by the large volume of steam, otherwise they would have re-combined. In many experiments in the laboratory we use the electric spark to explode mixtures of oxygen and hydrogen, and it is, in fact, the only means we can employ if we have to measure the amount of condensation which follows the explosion. We can readily produce, in furnaces, degrees of temperature amply sufficient for the decomposition of water (2000°C. , or 3632°F.), and there is not the slightest doubt that such decomposition is constantly taking place; but the gases are immediately re-combined. But there are complications in this case—the carbon of the fuel reacts upon a portion of the watery vapour, and carbonic oxide and carburetted hydrogen result, which, on the top of the fuel, burn to carbonic acid and water—exactly the same result following as if there had been no decomposition of the water. As the heat absorbed or rendered latent in the act of decomposition is exactly equivalent to that which results from the subsequent combustion, it follows that the introduction of steam into a furnace does not increase the gross amount of heat due to the combustion of the fuel, but it frequently has the useful effect of carrying forward in the furnace the zone of highest temperature, and so serves a useful purpose.

Perhaps the most important example of dissociation presented to us within a comparatively recent period is that of carbonic acid gas, which was effected by Deville in 1868. This eminent chemist showed that at an extremely high temperature carbonic acid (CO_2) is dissociated into carbonic oxide (CO) and oxygen. Further than this, CO is decomposed, two atoms of it giving one atom of carbon and one atom of carbonic anhydride, the ultimate result being the re-solution of the original compound into carbon and oxygen. A peculiar arrangement is required for the performance of this process—a ring of metal kept cold by a current of water being close to the gases, heated to an intense degree by the electric spark, and the carbon is deposited upon the cold metal. I consider this a most important discovery, not merely as a scientific fact, but as an explanation of phenomena which could not otherwise be accounted for. In an ordinary furnace, such as those employed in the Siemens-Martin process, and others in which an intense heat is obtained, there is evidently a limit beyond which no further increase of temperature can

be obtained—for this reason, that carbon and oxygen refuse to combine at a very exalted temperature, the exact degree of which we cannot exactly define, but which has been estimated at about 5000°F.

In the compounds of carbon and hydrogen we have a more familiar illustration of dissociation. If we pass one of the gaseous hydrocarbons, containing a large proportion of carbon—such, for example, as ethene (C_2H_4), popularly known as olefiant gas, or the vapour of a liquid hydrocarbon such as benzene, or of a solid such as naphthalene through a glass tube heated to bright redness, a deposit of carbon takes place, and the gas or vapour that passes on contains a greater or less proportion of methane or marsh-gas (CH_4). This is a well known fact in some manufacturing processes. In gas making, the retorts, especially at the back, become coated, often to the extent of several inches in thickness, with a solid deposit of carbon, which results from the decomposition of the gaseous liquid and solid hydrocarbons evolved from the coal by the action of heat. We may go further than this, and say that the production of illuminating gas from coal is itself an illustration of dissociation, for carbon is left behind, mixed with the mineral matter of the coal, forming coke, while the hydrogen and oxygen combine with a portion of the carbon, forming gaseous and liquid hydrocarbons and carbonic oxide, besides some other compounds containing sulphur and nitrogen. Again, if we distil coal-tar or crude paraffin oil we obtain in the retort or still a portion of solid carbon and a distillate of oils, containing less carbon than the original liquid. If we bring paraffin oil drop by drop, or in a thin stream, into a gas-retort heated to bright redness, a thin and poor gas is obtained, and much solid carbon is set free, but at a low red-heat a rich gas is produced, with no carbonaceous deposit. But to pursue this subject further, marsh-gas, by exposure to a still higher temperature, either by the electric spark or in a porcelain tube placed in a furnace, yields hydrogen and a richer hydrocarbon, acetylene (C_2H_2), which in turn is decomposed into carbon, hydrogen, and some marsh-gas, the ultimate result being that all hydrocarbons are resolvable by heat alone into carbon and hydrogen.

I could dwell on this subject much further, but it is unnecessary. Let us now see to what conclusion these experimental results lead. It is simply this—that by the action of heat all compound bodies are resolvable into their elementary constituents, and that if we had a world, or planet, or sun, the temperature of which was sufficiently high, we should there have simply a collection of elementary bodies. That is a conclusion to which we are forced by experiment and analogy. Some of us may not be able to realise the existence of such conditions as I have stated as being necessary, but we must acknowledge that, if such conditions did exist, the result would follow, just as we accede to the statement that if water is exposed to a sufficiently low temperature it will freeze.

(To be continued.)

CORRESPONDENCE.

CAUSTIC POTASH.

To the Editor of the Chemical News.

SIR,—In the midst of a general depression of the alkali trade, there is a branch which has, I think, been somewhat overlooked by our usually enterprising manufacturers. I mean the production of a "Commercial Caustic Potash" suitable for soft soap makers. As is well known, the usual method of obtaining caustic potash lye is by causticising American potashes (solution) at a high specific gravity, drawing off the supernatant clear liquor for saponifying the oil, and washing the residual lime several times, and using this for making up a fresh quantity of lye instead

of water. This process involves a large outlay of capital and occupies a very considerable space, and, moreover, it is a very unscientific or "rule-of-thumb" process, giving a product of very uncertain composition. What is required is a caustic potash containing about 70 per cent hydrate of potash and reasonably free from soda salts and carbonic acid. If such an article could be produced at a moderate price, it would be a great boon to soap makers, and I am certain it would command a large sale. As far as I can ascertain, there is only one works in England producing caustic potash, and their product is certainly very pure, but the price is proportionately high; doubtless it is very costly to manufacture this high-strength article. There may be obstacles in connection with the manufacture of this article, but I have no doubt the skill and perseverance of our chemists would overcome these difficulties.—I am, &c.,

R. J. T.

St. Helens, January 17, 1882.

THE NEW ALKALOID—HOMO-QUININE.

To the Editor of the Chemical News.

SIR,—Mr. David Howard, by his letter in the *CHEMICAL NEWS*, vol. xiv., p. 21, seems to imply that the note by Mr. Barret and myself (vol. xiv., p. 6) casts some doubt on the existence of homo-quinine. I beg to point out, therefore, that we did not give expression to any such doubt. Mr. Howard is a high authority on such matters, and we had no desire to call in question his results. We merely directed attention to a compound that may be easily formed in working cuprea barks, and, from its property of crystallising from ether, might be mistaken for the new alkaloid.—I am, &c.,

C. H. Wood.

Mildmay Chambers, 82, Bishopsgate St., E.C.,
January 17, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 26, December 26, 1881.

Mode of Action of Soluble Ferments.—A. Wurtz.—The author's experiments show that the two soluble ferments, pepsine and papaine, whilst becoming fixed in the insoluble state upon certain albumenoid bodies, modify these latter, so that they can become hydrated at a temperature of 40° by the action of pure water, forming true peptones.

Contractions and Expansions Produced by Electric Tensions in Hemihedral Crystals with Inclined Surfaces.—J. and P. Curie.—When the two extremities of the axis of a hemihedral crystal are charged with opposite electricities it undergoes along that axis, either contraction or expansion, according to the direction in which the electric tension has been applied.

Influence of Heat and of the Proportions of Glycetin on the Decomposition of Oxalic Acid.—M. Lorin.—The etherification of formic and oxalic acids in this kind of experiments is a secondary accident.

Decomposition of Certain Metallic Acetates in Presence of Water: Production of Crystalline Mineral Species.—J. Riban.—The acetates are not decomposed in the same manner as the formates (*Comptes Rendus*, xciii., pp. 1023 and 1082), evolving carbonic acid and marsh-gas, but are resolved into acid and metallic oxides, sometimes well crystallised, and some gases re-

sulting from the ulterior action of the regenerated compounds, but no hydrocarbons.

Essence of Angelica.—M. Nauden.—The chief constituent of this essence is an isomer of the oil of turpentine, $C_{10}H_{16}$. It is a colourless liquid, boiling at 175°, and having a smell of hops. Its density at 0° = 0.833.

Method of Purifying Arsenical Copper.—J. Garnier.—The author operates on a basic hearth of lime and tar; according to the process of Riley and Gilchrist, and at each operation he uses a false hearth of lime-stone mixed with peroxide of manganese. During the fusion of the ingots this false hearth is heated and gives off carbonic acid and a part of its oxygen. These gases traverse the mass of half-melted copper. When the bath is sufficiently liquid the lime and the manganese oxide thus formed rise through the copper and dissolve the arsenic acid, which passes into the slag. To expel the last traces the copper is allowed to become pasty in a current of air, and is then re-melted with the addition of basic fluxes till entirely purified.

Bulletin de la Société Chimique de Paris.

Tome 36, Nos. 6 and 7.

Russian Chemical Society.—Meeting of Feb. 5/17, 1881.—The President communicated the following researches conducted in the laboratory of the University of Moscow:—On dipropyl-oxalic acid, by M. Rafalsky; on the fumaric and terephthalic acids, by M. Lapine; on the petroleum of the Caucasus, by MM. Markownikoff and Oglobline.

M. Petouhoff communicated a paper on the reduction of carbonic anhydride by sulphur.

M. Menschutkin explained a method of determining the chemical value of the components of the alcohols. He also presented to the Society, on behalf of M. Tommasi, a dissocioscope,—an instrument for showing the dissociation of ammoniacal salts.

M. Lavroff announced that he had not succeeded in preparing carbon oxychloride by M. Paterno's method.

M. Chichkoff called the attention of the Society to certain regularities presented by the atomic weights of the elements. On occasion of this communication—

M. Boulterow announced that he had undertaken researches on this subject, which he proposed to continue. He remarked that on the one hand the researches of M. Stas have clearly established that the majority of the atomic weights could not be presented by whole numbers. On the other hand, the majority of the atomic weights differ from whole numbers so slightly that this fact can scarcely be regarded as accidental. May it not be admitted that under certain conditions the atomic weights may be really expressed by whole numbers with reference to H = 1? That is to say can we not admit that the atomic weights present values capable under given conditions of varying within certain limits. Such a hypothesis would not be absolutely inadmissible, for the atomic quantity of an element is in reality merely the vehicle of a determinate quantity of chemical energy; but the value of such a quantity must be determined not merely by the mass, but also by the velocity. This latter being changeable, the mass may likewise be modified, so long as the chemical value remains invariable. However this may be the absolute invariability of the atomic weights is an *a priori* hypothesis which has not yet been based upon exact experiments. M. Stas, when verifying the constancy of the composition of ammonium chloride prepared by different processes, evidently entertained ideas of the same order. It is therefore not useless to check experimentally the invariability of the atomic weights, and on this account the author has undertaken the determination of the weights of white phosphorus and red phosphorus.

M. Wagner communicated a general method of preparing the secondary alcohols.

M. Butlerow announced that he had repeated the ex-

periment of Mr. Carnelley by heating ice under a feeble pressure, but without succeeding in raising its temperature. M. Louguine made a communication on the combustion-heat of the tertiary glycol, pinacone.

Moniteur Scientifique, Quesneville.
November, 1881.

Studies on the Alkaloids.—M. de Bechi.—A continuation from the October number.

Influence of Coal-Dust in Explosions in Coal Mines.—Prof. Abel.—A translation from the English.

Exhibition of 1878.—C. Lauth.—The author describes the artificial production of vanilline, of salicylic acid, the production of trimethylamine and methyl chloride from the dregs of the distillation of beetroot treacle, and the manufacture of the alkaloids.

The Action of Pilocarpine upon the Colour of the Human Hair.—Dr. Prentiss.—Pilocarpine, the alkaloid of jaborandi (*Pilocarpus pennatifolius*), used in medicine as a sudorific, has been found when administered by hypodermic injection to alter the colour of the hair from a light blonde to an almost pure black.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 14, 1881.

The Abbé Moigno complains, in an able article, of the treatment which M. Tommasi has recently experienced in the suppression of his researches on the decomposition of water and their subsequent appropriation.

Electric Machines.—H. Valette.—A continuation from No. 12, containing several illustrations.

Journal für Praktische Chemie.
Nos. 19 and 20, 1881.

Opianic Acid.—O. Prinz.—By the action of nitrous acid upon opianic acid it yields a small quantity of nitro-hempinic acid. Dilute nitric acid gradually converts opianic acid into hempinic acid. Monohydrated nitric acid gives rise to nitro-pianic acid, $C_{16}H_{19}NO_7$, nitro-hempinic acid, and an insoluble unnamed body. By the reduction of nitro-pianic acid with stannous chloride, he obtained azo-pianic acid. On treatment with potassium chlorate and hydrochloric acid there is formed monochloro-pianic acid. Bromine likewise yields with opianic acid a substitution-product. The author likewise examines the methyl-noro-pianic acid of Matthiessen and Foster, formed by the prolonged treatment of opianic acid at root. He also examines the action of phosphorus pentachloride upon the hempinic and the opianic acids, and the reduction of opianic acid chloride.

My Part in the Development of Theoretical Chemistry (Fourth and last Part).—H. Kolbe.—A long and severe, but exceedingly able, critique on Kekulé and his school.

Trichlor-quinonimide and its Transformations.—R. Schmitt and M. Andresen.—The authors describe trichlor-para-amido-phenol, trichlor-quinon-chlorimide and its behaviour with aromatic primary amines, with dimethyl-aniline; the behaviour of trichlor-quinon-dimethylaniline-imide with reducing agents, trichlor-dimethylanilido-phenol, and trichlor-dimethylanilido-phenol-sulphonic acid.

Apparatus for Receiving and Measuring Gases, and especially for the Direct Determination of Nitrogen.—R. Schmitt.—The construction of the apparatus cannot be made intelligible without the accompanying illustration.

Transformation of Morphin: into Codeine and Analogous Compounds.—E. Grimaux.—From *Comptes Rendus*, 92, p. 1140, and 93, p. 67.

Zeitschrift für Analytische Chemie.
Vol. xx., Part 3.

Remarks on the Analysis of Water.—A. Wagner.—The author considers the process of Frankland and Armstrong quite excluded in case of the water of town-wells and of streams which have received sewage or manufacturing refuse. The methods depending on the reduction of silver nitrate or potassium permanganate are equally to be rejected. For the qualitative detection of nitrates in well-waters, the author recommends the brucine process, conducted as follows: He pours 1 c.c. of the water in question into a small porcelain capsule holding about 10 c.c.; he then adds a granule of brucine, and, by means of a platinum spoon holding this quantity, $\frac{1}{2}$ c.c. of concentrated sulphuric acid. With small traces of nitrates there appears immediately, where the brucine lies, a transitory red reflection. In this manner 1 part of a nitrate may be detected in 500,000 parts of water. The diphenylamine reaction is equally sensitive. It is applied in the same manner as the brucine test, but a double quantity of sulphuric acid is used. If the nitrate is present in large proportions, an intense blue colour immediately appears; if the quantity is small, the blueness is seen after a little time, and passes into a yellow. This reaction is even less interfered with by the presence of organic matter than that with brucine. As regards the quantitative determination of nitrates, the author rejects the process of Schlösing, except in waters rich in nitrates and organic matter. He condemns the methods based on the oxidation of indigo. Where time is an object he proposes the following method: Pour into a flask fitted with a stopper a known volume of distilled water. If the water under examination—and which has been found to give a perceptible reaction with brucine—is added from a burette, constantly agitating, a point is reached at which a c.c. of the mixture, if taken out and tested, gives a perceptible redness. In this case 1 litre of the mixture of known quantities of distilled water and of spring-water must contain between 2 and 1.66 milligrams of nitrate and of course equivalent proportions of nitric acid.

Limits of Sensitiveness of some Reactions for Iron and Copper.—A. Wagner.—For iron, the author finds the limit of visible reaction with potassium ferrocyanide 1 part in 500,000; with potassium sulphocyanide, 1 part in 1,600,000; and with tannic acid, 1 part in 350,000, the limit in this latter case being indistinct. For copper, with ferrocyanide, the limit is 1 part in 200,000 of water; with ammonia, 1 part in 25,000; and with potassium xanthogenate, 1 part in 900,000 of water. For silver, with potassium xanthogenate the limit is 1 part in 40,000 of water. For mixtures of ferric and cupric salts, with potassium ferrocyanide the blue reaction was faintly perceptible in a mixture of 31 vols. cupric and 1 vol. ferric solution, each containing 1 part metal in 10,000 water. With ammonia the blue reaction was first perceptible in a mixture of 1 vol. cupric and $\frac{1}{2}$ vol. ferric solutions, each containing 1 part metal in 10,000 water. If the iron is in larger proportion there appears merely a yellow colouration. On these limits of reaction the author founds an approximate method for the determination of iron and copper, the procedure being in principle the same as that above described for the determination of nitrates.

The Determination of Potassium in Potassium Sulphate.—Dr. West.—The author remarks that the ordinary method of removing the sulphuric acid by means of barium chloride and converting the excess of the latter into barium carbonate by evaporation and ignition with oxalic acid, is open to a double objection. Barium sulphate retains much potassium chloride, even in an acid solution, and during the ignition a further quantity of barium chloride is lost by volatilisation. At Stassfurt the following method is in use: 10 grms. of the salt in question are placed in a 500 c.c. flask, with 350 to 400 c.c. of water and 25 c.c. of hydrochloric acid at 25 per cent, and solution of barium chloride (almost saturated, and con-

taining 50 c.c. aqueous hydrochloric acid (per litre) is gradually added, boiling up each time, till the sulphuric acid is exactly thrown down, a point easily reached with practice. A very small excess of sulphuric acid has no effect upon the result, whilst an excess of barium chloride increases the result. Or the sulphuric acid in the salt may be determined volumetrically in a separate portion with barium chloride and potassium chromate, and the quantity of barium chloride thus found is added to the potassium salt in an acid solution. In evaporating, care must be taken that the free hydrochloric acid is entirely expelled, which is not easy in presence of much magnesia, otherwise an error may arise of 0.5 per cent. The correction for the potassium chloride retained by the barium sulphate is as follows: In 10 grms. potassium sulphate there are 4.59 sulphuric anhydride = 13.79 grms. barium sulphate, which occupy the space of 3 c.c. Each c.c. of the precipitate contains as much potassium as 6 c.c. of the solution.

Testing Petroleum.—C. Engler and R. Haass.—The three physical properties, refraction, specific gravity, and boiling-point, afford neither singly nor taken together an indication of the safety of a sample of petroleum.

The Detection of Magenta, Orchil, and Cudbear in Wine.—Dr. B. Haas.—According to Romi 100 c.c. of wine are mixed with an excess of basic lead acetate, heated, and filtered. To the filtrate a little more basic lead acetate is added in order to ascertain if the precipitation was complete, and the filtrate is then shaken up with amyl alcohol. The two colours, orchil and magenta, are then distinguished as follows: The red stratum of amyl alcohol is carefully poured into a dry test-tube and mixed with water. It is decolourised if the red colour was due to magenta, but not if it is owing to orchil or cudbear. The baryta method of Pasteur, Balard, and Wurtz, and the magnesia test, are useless if it is required to distinguish magenta from orchil and cudbear.

Determination of Phosphoric Acid in the Ashes of Grain.—E. v. Raumer.—In order to avoid the conversion of the phosphoric acid into pyro-phosphoric acid during carbonisation, the author adds baryta-water and dries, when carbonisation takes place rapidly at a moderate temperature.

An Improvement in Reading off Hydrometric Degrees, especially for Determining the Specific Gravity of the Fatty Matter of Butter.—A. Mayer.—This paper requires the accompanying illustration.

The Reactions and the Detection of Glycerin.—E. Donath and J. Mayrhofer.—To detect glycerin in the possible presence of sugar, the liquid in question is mixed with powdered slaked lime and an equal bulk of fine quartz sand, and evaporated to a paste on the water-bath. When cold the residue forms a hard mass, which is pulverised and extracted with 80 to 100 c.c. of a mixture of equal volumes of absolute alcohol and ether in a small stoppered flask. On allowing the extract to evaporate, the glycerin is obtained free from sugar. If two drops of it are put in a dry test-tube with two drops of phenol (previously liquefied), and the same quantity of sulphuric acid, and heated very cautiously over the flame, but so as to reach 120°, the formation of a solid brownish yellow mass is perceived. When cold a little water is added, and a few drops of ammonia, when the brownish yellow solid dissolves with a splendid carmine red colour.

MISCELLANEOUS.

Animal Chemistry in the Daily Press.—An evening paper informs the public that "we need even siliceous particles to form our bones." Considering that the silica found in recent bones is about 0.1 per cent of the total mineral matter, the "need" does not seem very pressing.

Recognition of the Pitomaines.—Brouardet and Boutmy assert that the pitomaines quickly reduce potassium ferricyanide, which the vegetable bases are unable to effect. P. Spica shows experimentally that this distinction does not hold good, and that the ferricyanide is reduced also by the vegetable bases.—*Gazzetta Chimica.*

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns. Glycerin.—Would any kind reader give me a good confirmatory test or two for glycerin. I have looked in various books but have been unsuccessful in meeting with one.—W. Ray.

MEETINGS FOR THE WEEK.

- MONDAY, 23rd.—London Institution, 5.
Medical, 8.30.
TUESDAY, 24th.—Institute of Civil Engineers, 8.
Royal Institution, 3. "The Mechanism of the Senses," Prof. J. G. McKendrick.
Royal Medical and Chirurgical, 8.30.
WEDNESDAY, 25th.—Society of Arts, 8. "The Causes and Remedies of Bad Taste," by Walter R. Browne, M.A.
Geological, 8.
King's College Science Society, 8. "The Action of Light upon Certain Substances, and its Application to Photography," by J. M. Thomson F.R.S.E., F.C.S. (Admission by private card).
THURSDAY, 26th.—Royal, 4.30.
Royal Institution, 3. "Corals," Mr. H. N. Mosely.
Philosophical Club, 6.30.
Society of Arts, 8. "Recent Researches into the Theory of the Living Contagium, and their Application to the Prevention of Certain Diseases in Animals," by T. L. W. Thudichum, M.D.
London Institution, 7.
FRIDAY, 27th.—Royal Institution, 8. "The Museum and Libraries of Alexandria," by Mr. R. S. Poole, 9.
Quekett Microscopical Club, 8.
SATURDAY, 28th.—Royal Institution, 3. "Ludwig van Beethoven," by Prof. Fauer.
Physical, 8. "On the Fluid Density of Metals," by Prof. W. Chandler Roberts and T. Wrighton.
"On Apparatus for Calculating Efficiency," by C. Vernon Boys.
"On a New Electric Meter," by C. Vernon Boys.

TO CHEMICAL MANUFACTURERS &c.

DARWEN CORPORATION GAS WORKS.

The Gas Committee of the above Corporation are prepared to receive TENDERS for the Surplus Tar and Ammoniacal Liquor produced at these Works for one, three, or five years, from March next. Coals carbonised, about 9000 tons annually. Further particulars and Forms of Tender may be had on application to the undersigned.
Sealed Tenders, endorsed "Tender for Tar or Ammonia Liquor," to be sent to C. COSTERRE, Esq., Town Clerk, Darwen, on or before February 14th next. By Order—

THOS. DUXBURY,
Manager Gas Works, Darwen.

ROYAL POLYTECHNIC, open for four weeks only.—The Institution having been sold, it will positively and finally close on the 21st of January. Until then, a most varied and attractive programme will be presented daily, including new Musical, Optical, Magical, and Popular Scientific Entertainments, as well as a *reclassement* of very many of those that have delighted its audiences during the last 20 years. The Institution remains open from 12 till 10, with a continuous series of Entertainments, and without any extra charges. Distributions of Gifts from the Christmas Tree to every juvenile visitor, on Wednesday afternoons. Admission 1s.; children under ten, 6d.—Manager, Mr. James Howell.

Chemical Balance for Sale.—One of Oertling's 24 grams; scarcely ever been used, and as good as new.—No reasonable offer refused.—Address, W. J., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

THE CHEMICAL NEWS

VOL. XLV. No. 1157.

MANOMETRIC OBSERVATIONS IN
THE ELECTRIC ARC.*

By Professor DEWAR, F.R.S.

THE experiments recorded in my former paper, entitled "Studies on the Electric Arc,"† together with the numerous observations made conjointly with Professor Liveing on the spectrum of the arc discharge between carbon electrodes in different gases, led me to ascertain if the interior of the gaseous envelope of the ordinary arc showed any peculiarities of pressure. Pressure might be caused by the motion of the gas particles, the transit of material from pole to pole, electric action, or indirectly by chemical combinations taking place in the arc. As any effect due to the above causes must necessarily be very small, a delicate manometer capable of measuring easily the one-hundredth of a millimetre of water pressure had to be employed. The records of such an instrument in the present series of experiments, are complicated by the indirect action of the hot currents of air passing the poles, and the irregularities in the steadiness of the arc which undoubtedly cause marked variations of pressure; yet by multiplying and varying the conditions of the experiments, it is possible to eliminate these secondary effects and secure reliable results. The apparatus consists of two hollow carbons, like what I have formerly employed in the separation of cyanogen from the arc.‡ They must be free from all porosity before they can be used in the experiments to be detailed, and the drilled hole should not be less than three millims. in diameter. In order to fill up minute apertures in the carbons, and render them non-porous, they are placed in a porcelain tube and heated to a white heat in a current of coal-gas saturated with vapour of benzole. This treatment causes the deposition of a layer of dense metallic carbon over the surface of the tubes, which renders them capable of withstanding a considerable interior pressure of air or other gas without exhibiting leakage. The hollow poles are connected by means of tubing with two manometers. The tubes leading from the hollow poles have been made of metal or thick india-rubber, and to prevent heating of the tubes and manometer by radiation from the arc, they have been carefully guarded by hollow tin screens through which a current of water flowed continuously. The lengths of the tube between the manometers and poles have been varied, and in some cases the tube made into a spiral form has been immersed in water so as to guard against unequal heating. In the experiments water, ether, and alcohol have been used in the manometers, but the largest number of the experiments have been made with ether. This fluid is most convenient from its mobility, and the only precautions to be taken are to use plain cork stoppers instead of india-rubber, and to have a considerable length of tube between the manometers and the arc. By careful levelling and the use of ether as the fluid 1 millim. of motion of the fluid in the horizontal tube may be made to correspond to about the 250th of a millim. of water pressure. In the present investigation, as the absolute value of the pressure is not so important as the general variation, I have not thought it advisable to give other than relative records taken with the same instrument at different times; it is quite possible, however, to get absolute values of very small pressures by means of

this instrument, and I have satisfied myself of its accuracy by measuring a series of pressures of soap bubbles of different sizes, which confirm the previous observations of Plateau that the internal pressure varies inversely as the diameter of the bubble.

When the arc passes between two pointed carbon poles it assumes two very different forms; in one case the envelope of the intensely heated gaseous materials is well defined, almost spherical in appearance, surrounding the whole of the end of the positive pole, but touching the negative only at a single point without showing that close adhesion to the pole which is so characteristic of the layer of gas at the positive. At other times the arc is very unsteady, noisy with apparent blast of green flame-looking ejections, which generally arise from the positive pole. These blasts are invariably associated with a great increase of intensity in the hydrocarbon and cyanogen spectrum. While the arc is in this unstable condition manometric observations are impossible, as the small area of the carbon tube is rarely completely covered by the arc, so that the manometers often record neither positive nor negative pressures during the discharge. The effect of the hot poles on the registration of the manometers is to produce a small negative pressure when the arc has stopped, due to the passage of currents of hot air. Many experiments were made to ascertain if a local heating of the carbon tube caused any permanent pressure. This was carefully tested by taking the arc at right angles to a carbon tube placed in a block of magnesia so as to raise the middle of the tube to the highest possible temperature. Under these conditions the manometer connected with the hollow carbon remained perfectly steady; whether the tube was made the positive or negative pole of the battery. This experiment also showed that repulsion of the inclosed gas in the tubes through an electric charge, had no effect on the manometer. During the maintenance of the steady arc, the manometer connected with the positive pole exhibits a fixed increase of pressure, corresponding to a motion of the fluid in the horizontal tube of the manometers employed, of from 50 to 150 millims., which is equivalent to from 1 to 2 millims. of vertical water pressure in different experiments and under varied conditions. The manometer connected with a negative pole shows no increase of pressure, but rather on the average a diminution.

When the arc begins to emit a hissing sound, the pressure on the positive pole instantly diminishes, and when blasts are ejected from the positive in the direction of the negative, the negative manometer which had stood at zero before showed a marked increase of pressure. If a commutator is placed in a circuit, so as to quickly reverse the direction of the original current, the arc is not broken, but the manometers immediately record a reverse action. In order to equalise the temperature of the poles to some extent, the arc was taken in the middle of a block of magnesia, but the same results were observed; the pressure is generally smaller in the hot crucible than it is in air. When the crucible gets highly heated and filled with metallic vapours, the arc will pass a distance of more than an inch, and in this condition the shorter the arc the greater the pressure. It was found advisable in these experiments to use a negative pole which had a sharp conical termination, otherwise the form of the arc in the block of magnesia was very irregular, owing to the high conductivity of the hot walls of the crucible. When the poles are brought into contact in the magnesia crucible, the pressure at the positive instantly falls.

Whether air, carbonic oxide, or nitrogen filled the manometer and carbon tubes the results were invariably the same. The chief experiments have all been made with the Siemens machine, but a 70 cell Grove's battery produced the same results. The use of the horizontal arc is a matter of convenience, as in this condition the manometers are least affected by air currents, but the same general action may be observed by the use of vertical poles. A thin carbon spatula placed in front of the end of the

* Abstract of a Paper read before the Royal Society, January 19th, 1882.
† Proc. Roy. Soc., 1880, page 85.
‡ Proc. Roy. Soc., 1879, page 165.

positive pole at once lowered the positive pressure of the manometer. This experiment does not prove much, as the carbon diaphragm causes a noisy and unsteady arc until a minute hole is pierced by the current. It is probable the diminution of pressure may be due to the instability of the arc. In the same way the action of the magnet on the arc causes an instant reduction of the positive pressure by withdrawing the arc from completely covering the end of the carbon tube, so that this action must be regarded as an indirect one. A small carbon tube connected with a manometer was inserted into the arc, passing between two solid carbons, so as to take a section at right angles to the passage of the current. In this condition the arc is apt to be irregular in shape, and to pass rather between three poles than two, but the average records point to an increase of pressure in this position also. When the negative carbon tube is about 1 millim. in diameter, and the point sharp and the tube short, so as to diminish any air friction, the negative pole manometer seems also to give a positive pressure.

It appears from the above experiments that the interior of the gaseous envelope of the electric arc always shows a fixed permanent pressure, amounting to about a millimetre of water above that of the surrounding atmosphere. This looks as if the well-defined boundary of the heated gases acted as if it had a small surface tension. This pressure may be due to various causes; motion of the gas particles under the conditions; transit of material from pole to pole; or a succession of disruptive discharges, and a more elaborate investigation will have to be made before the origin of the excess of pressure is clearly defined.

ON A METHOD FOR ESTIMATION OF ORGANIC NITROGEN IN LIQUIDS AND SOLIDS.

By WILLIAM BETTEL.

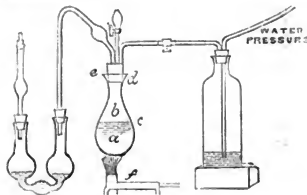
PRELIMINARY NOTICE.

THE difficulty and expense of Dr. Frankland's process for organic nitrogen determination led me to devise a method less expensive than the soda lime process, and unfailing in accuracy, easily worked, and estimating either large or small quantities of nitrogen as ammonia by titration or Nesslerising. I found that by removing nitrates by the copper zinc couple, I could easily estimate the total organic nitrogen in solution by evaporation of water (after removing ammonia, free, and from decomposition of nitrates), with pure solution of caustic soda in a copper flask of peculiar shape, finally evaporating to dryness and igniting, adding water, and re-distilling. I could, by suitably collecting the ammonia, obtain results which agreed with the previous history of the water as regards contamination. Having perfected the method I found that urine, abnormal and healthy, and organic fluids in general, including milk, beer worts, extracts, &c., containing no nitrates, could be thus examined far quicker than by any other known process for total nitrogen estimation, whilst for simplicity and accuracy it resembled an ordinary ammonia estimation by distillation. Where, upon ignition, cyanides are formed in the flask, sufficient permanganate is added to oxidise to cyanates. These by ebullition are converted into ammonia, and so estimated. I have obtained theoretically accurate percentages of ammonia from ferrocyanide of potassium, urea, uric acid, hippuric acid, albumen, &c., and slightly higher results for other substances, solid and liquid, than yielded by the soda lime process.

At present I will content myself with giving a sketch of the copper flask I use for general work, merely mentioning that the apparatus is in use in two large breweries in the country for daily examination of yeast, malts, worts, and beer. The capacity of the flask is about 300 c.c., and is

made in three pieces. *a*, beaten out of stout sheet copper, and brazed to *b*, made of drawn tube, at junction *c*. The copper cup, *d*, is intended to hold a little water to cool cork inserted in neck, *e*, when the lower part is heated to redness. The cork is triply perforated to admit of stoppered separating funnel tube, tube from hydrogen gas-holder (conveniently made out of two "Winchester quarts"), and the third to either condenser or bulb arrangement with normal sulphuric acid, with methyl-orange as indicator.

The following drawing shows the apparatus as arranged for titration of NH_3 .



I have had a number of the copper flasks made specially, and shall be happy to supply them with the necessary fittings to any chemist, with the mode of procedure.

29, Castlemain Road, Camberwell,
London, S.E.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, January 19, 1882.

Prof. H. E. Roscoe, President, in the Chair.

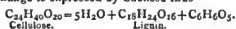
THE following certificates were read for the first time:—H. J. Alford, A. Blaikie, W. E. Bush, J. F. Beringer, G. W. Davies, W. Hamilton, T. Isherwood, H. H. Phillips, H. Porter, C. H. Ridsdale, V. P. Sells, L. T. Thorne, S. Young. During the evening a ballot was held, Drs. Wright and Japp being appointed scrutineers. The following gentlemen were declared duly elected Fellows of the Society:—F. Barkas, E. D. Chester, J. Gray, H. E. J. Irons, J. P. Laws, F. H. Lescher, D. O. Masson, H. F. Moore, T. Perry, J. R. Parker.

THE PRESIDENT then called on Mr. CROSS to read a paper on "The Chemistry of Bast Fibres," by C. F. CROSS and E. J. BEVAN. In a previous paper (see CHEMICAL NEWS, vol. xlii., p. 77, and Chem. Soc. Journ., xxxviii., p. 666), the authors established the following points:—The chemical similarity between the non-cellulose constituents of mono-cotyledonous and di-cotyledonous fibres; the resolution of the jute fibre by chlorine into cellulose (using this name in a general sense) and the chloro-derivative of an aromatic body, $\text{m}(\text{C}_{10}\text{H}_7\text{Cl}_2\text{O}_2)$, all bast fibres examined (flax, hemp, manilla, esparto, &c.), yielded a similar body. The reactions of this substance suggested the hypothesis that it was a complicated derivative of tetra-chloro-quinone. Jute fibre was resolved by boiling dilute hydrochloric or sulphuric acid into a soluble carbohydrate, and an insoluble compound of the aromatic body with the more stable form of the cellulose. Dilute nitric acid resolves the fibre into cellulose and a nitro-derivative

of the aromatic constituents, $\pi(C_{25}H_{31}(NO_2)O_{13}H_8)$. No constituent of the nature of pectose was found. From these facts the authors drew the conclusion that jute fibre consists of cellulose intimately associated with a complicated body allied to the quinones, in fact, a cellulide, after the type of the glucosides, the aromatic body being united to cellulose in place of glucose. They also observed that the chlorinated body when treated with a solution of sodium sulphite develops a magnificent purple colour; this reaction was applied for the detection of bast fibres. In the present paper the authors have continued this line of research. To the aromatic constituent of the jute fibre the authors assign the formula, $C_{19}H_{12}O_8$. The resemblance of this formula to that of catechin, $C_{15}H_{10}O_6$, suggested a comparative investigation of the latter substance; both catechin and catechu-tannic acid yielded a chlorine derivative resembling that mentioned above, which gave a brilliant magenta colour with sodium sulphite. Moreover, from a specimen of jute fibre which had become rotten through shipment in a damp state, a body was extracted by water having all the properties of tannin. Esparto resin, when fused with potash, furnished phloroglucin and much proto-catechuic acid. The general identity of these non-cellulose constituents with the class of astringent substances or tannins, is thus fully established. The authors then give details as to the bromine and chlorine compounds obtained from esparto resin. They next investigate the action of caustic alkalies on the chlorine derivative, $C_{19}H_{12}Cl_2O_8$, of jute fibre, by which adduct two atoms of chlorine were removed, as is the case with chloranil. By the action of bromine on jute fibre a brominated compound was obtained similar to that from esparto resin. As regards the constitution of these derivatives the authors are inclined to believe that their molecule is built up round chloranil as a centre. Chloranil when boiled with sugar, forms a brown substance, which behaves with alkalies and chlorine exactly like the aromatic substance obtained from bast fibres. The authors next consider the wider problem of the relation of the cellulose to the non-cellulose constituents of bast fibres, and the relation of both to the life of the plant. In these points they have been anticipated by the investigation and inferences of the physiological botanists, Sachs, Sachsse, &c., who have stated that cellulose is directly derived from starch, or its physical equivalents, sugar, fat, or inulin, and is not a product of the resolution of a proteid molecule; this formation of cellulose is attended with the evolution of carbonic anhydride. The chemical changes are expressed by Sachsse thus—



The molecule, $\pi C_6H_{12}O_6$, is then transformed into substances having the atomic ratio $C_6H_{10}O_5$. The formation of cellulose usually occurs in these portions containing no chlorophyll; the formation of starch, on the other hand, is associated with the presence of chlorophyll and the evolution of oxygen. The lignification of fibres originally consisting of pure cellulose is held by Sachs to be a modification of the cell substance (cellulose), and not an infiltration of substances from the contents of the cell. This change is expressed by Sachsse thus—



Sachsse thinks that it is to this more highly oxidised molecule, $C_6H_6O_3$, that the origin of the tannins is to be referred. The authors dissent from this equation, and think that bodies resembling meta-petic acid, $C_6H_4O_3$, are formed. Such bodies have been found by Kolbe in linen fibre, and by the authors in the portions of the jute fibre near the roots (jute cuttings). Sachs maintains that the tannins are degradation products of cellulose, and are to be looked upon as excreta, like urea in the animal. If now the extreme terms of the developmental series are the celluloses and the tannins, it devolves upon the chemist to investigate the intermediate stages of the transformation. The authors therefore treated jute fibre

with dilute (5 per cent) sulphuric acid at moderate temperatures. As a result of these experiments they conclude that the jute fibre consists for the most part not of cellulose, but of a transition form between the original carbohydrate and its ultimate modification of a soluble astringent. To this transitional modification the authors give the name of *bastose*, as the authors consider there are many celluloses, so also there will be many forms of bastose. The aromatic derivatives derived from these bastoses the authors propose to call *bastins*. The authors then adduce various arguments to prove that the conversion of carbohydrates into aromatic bodies is possible. Thus Hoppe Seyler by heating starch to high temperatures with water formed pyrocatechin. Gun-cottons or nitro-celluloses degrade spontaneously into bodies of the pectic class, and the authors by the action of strong sulphuric acid on dextrin at 70°, obtained a black substance, which furnished a chlorinated product resembling in its properties the chlorobastin previously described. The formation of the black substance was accompanied with that of acetic and carbonic acids. The authors conclude the paper with the results of several miscellaneous researches bearing on the subject. The stony concretions of pears can be converted into cellulose and a chlorobastin giving the colour reaction with sodic sulphite. The origin of tannins, the reactions of jute substance under high pressure, the reduction of indigo by jute, the reaction of linseed oil with sulphuric acid, and additional observations on the chlorobastins, are the titles of these miscellaneous researches. The authors finally embody their results in a diagrammatic survey or genealogical tree. Carbonic anhydride and water by the action of light protoplasm and chlorophyll form starch. Starch and oxygen during the growth of the plant gives off CO_2 and H_2O , pectin and cellulose being formed. The starch passes through bastose to bastin. Bastose can be split up in various ways—by chlorine into cellulose and chlorobastin, by dilute sulphuric acid into furfural, acetic acid, &c., and tannins (insoluble), by decay into pectic acid and tannins (soluble), by nitric acid into cellulose and a nitro-body. Bastin, by fusion with KHO , furnishes phloroglucin and proto-catechuic acid, and by chlorination carbonic acid and chlorobastin.

THE PRESIDENT congratulated the authors on having opened out a new field of research. The results seemed to him equally interesting and important, especially the connection between these bodies and the tannins.

Dr. GILBERT had listened with great interest to the paper. He hoped the authors would be able to continue the research, especially as to the conditions of plants in various stages of growth; such observations would be of the greatest advantage to physiological chemistry.

Dr. SCHUNCK had obtained some time back similar results as far as they went with cotton fibre. The subject was of interest both to science and technology. He was especially interested with the fatty and waxy matters.

Mr. Cross then read a paper entitled "A New Apparatus for the Determination of Melting-points," by C. F. CROSS and E. J. BEVAN. The apparatus consists of a small platform of thin ferrotypic iron or silver, having an opening for the reception of a thermometer bulb and a small indentation or depression about 1.5 mm. deep and 2 mm. in diameter. A very small quantity of the substance is melted in the little depression, and while still liquid a thin platinum wire, bent like an L and fused into a glass float, is immersed in the liquid and held there until the substance solidifies. A thermometer is then inserted in the opening, and the whole apparatus plunged under mercury. The mercury is gently heated, and the thermometer carefully watched. As soon as the substance melts the float rises instantly, and the temperature is noted. Stirring is unnecessary, the whole of the substance is surrounded with mercury, and the attention can be concentrated on the thermometer.

Dr. CARNELLY then read a paper "On the Action of Heat on Mercuric Chloride." About twelve months ago the author exhibited to the Society some experiments on

the action of heat on ice and mercuric chloride under low pressures, and subsequently read a paper on the subject before the Royal Society. Two propositions were advanced—(1) That when the superincumbent pressure is maintained below a certain point, called "the critical pressure," it is impossible to melt ice, mercuric chloride, and probably other substances, no matter how great the heat applied. (2) That under these circumstances ice and mercuric chloride attain temperatures considerably above their natural melting-points without melting. Subsequent observers have confirmed the first proposition, but have been unable to verify the second. The author has therefore repeated his previous experiments with mercuric chloride, and, in addition, has made determinations of the temperature of mercuric chloride, heated in a vacuum, by dropping the heated solid into calorimeters containing turpentine, benzene, and petroleum. Some unexpected results were obtained. When the salt is pressed as a compact powder round the bulb of the thermometer and heated in a vacuum, the thermometer rises 21° to 50° above the melting-point of the mercuric chloride, though still surrounded by the solid salt. When the salt is in the form of a solidified cylinder the temperature rises 15° above the melting-point. When a turpentine calorimeter is used the temperature of the mercuric chloride came out 100° above the ordinary melting-point; but with petroleum or benzene, temperatures above the ordinary melting-point could not be obtained. The author therefore withdraws his previous statement, and concludes that although mercuric chloride does not fuse when heated under diminished pressure, yet its temperature never rises appreciably above its ordinary melting-point, the high temperatures indicated by the thermometer being due to the diffusion of the superheated vapours of the mercuric chloride through the pores of the solid salt. The author also concludes that turpentine cannot be used in a calorimeter for the determination of the specific heat of bodies soluble in water, since some substances—such as mercuric chloride, zinc chloride, &c.—when heated cause an evolution of heat, due probably to the polymerisation of the turpentine. Hence many of Regnault's specific heat determinations, in which turpentine was employed, are probably too high; they are, it may be remarked, in almost all cases higher than Kopp's numbers, that observer having used coal-tar naphtha. The specific heat of mercuric chloride is 0.06425, and of zinc chloride 0.14301, neither value being altered by a rise of temperature.

The President complimented Dr. Carnelly on the energy and perseverance with which he had pursued the research, and explained the anomalies he had met with in its progress.

Dr. WRIGHT asked Dr. Carnelly if he had any chemical evidence of the polymerisation of the turpentine, and suggested that some experiments should be made with the mercuric chloride surrounded with a glass cylinder to prevent contact with the turpentine.

Dr. JAPP said that on boiling mercuric chloride with turpentine much cymene was formed.

Mr. KINOZETT stated that a somewhat similar action took place with zinc chloride.

Dr. CARNELLY, in reply to Dr. Wright, stated that he had not made any chemical examination of the turpentine.

"Contributions to the History of Cerium Compounds," by W. N. HARTLEY. This is an elaborate paper in seven parts:—I. "On the Preparation of Pure Cerium Salts." The author prepares these by the method of Mosander—i.e., precipitating the mixed hydrates of cerium, lanthanum, and didymium by means of potash and soda, and converting the lanthanum and didymium compounds into hypochlorites by means of chlorine, the ceric hydrate being left insoluble. II. "A Delicate Test for Cerium." To a solution, either acid or neutral, a solution of sodic acetate and hydrogen peroxide are added. A brownish red solution results if cerium is present, which darkens considerably. Thus we can detect and even separate 1 part of cerium in 100,000 of liquid. III. "The Preparation and

Analysis of Cerous Phosphate." It has the composition $\text{Ce}_2\text{O}_3 \cdot \text{P}_2\text{O}_5 \cdot 4\text{H}_2\text{O}$. IV. "The Preparation and Analysis of Ceric Phosphate." This salt has the composition, dried in *vacuo*, $(\text{CeO}_2)_2(\text{P}_2\text{O}_5) \cdot 36\text{H}_2\text{O}$. V. "Note on the Composition of Edwardsite and Manazite." Edwardsite is a ceric phosphate. VI. "The Analysis of Rhabdophane, a New British Mineral." This mineral was discovered by Mr. G. W. Lettson. Two specimens existed in the collection of the late Mr. Turner, and two specimens have been discovered by Prof. Maskelyne in the Oxford collection. They were classed as blendes. Mr. Lettson, when examining various British blendes for gallium, recognised in the light reflected from this dull garnet-red translucent mineral the characteristic spectrum of didymium. The author has carefully analysed the mineral. It contains per cent—Water, 9.34; silica, 0.36; Al_2O_3 , Fe_2O_3 with P_2O_5 , 0.21; magnesium phosphate, 1.09; cerous oxide, 23.19; lanthanum and didymium oxides, 34.77; yttrium oxide, 2.09; P_2O_5 , 24.77. Its formula may be written $\text{Ce}_2\text{O}_3 \cdot \text{Di}_2\text{La}_2(\text{P}_2\text{O}_5)_2 \cdot 41\text{H}_2\text{O}$, in which the three metals Ce, Di, and La may wholly or in part replace each other. VII. "Spectroscopic Analysis of Rhabdophane." The spectroscope consisted of a Rutherford diffraction grating, ruled on speculum metal containing 17,460 lines to the inch. The author separated out a pure yttrium salt, and has carefully measured the lines in its spectrum and calculated their wave lengths. Yttrium has not hitherto been found in any British mineral. A group of four lines in the green, closely adjacent to each other, were seen, which could not be connected with the spectrum of any known element.

"On the Reaction of Chromic Anhydride with Sulphuric Acid," by C. F. CROSS and A. HIGGINS. The authors have analysed the insoluble chromium compounds formed in the above reaction. Their composition is somewhat variable. One specimen gave the formula— $2[\text{Cr}_2\text{O}_3 \cdot \text{SO}_3] \cdot \text{H}_2\text{SO}_4$.

"On Dibenzyl-anilins and its Isomerides," by A. HIGGINS. The Society then adjourned to February 2, when a lecture "On the Unit Weight and Mode of Constitution of Compounds," will be delivered by Prof. Odling, F.R.S.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, November 24, 1881.

MR. JOHN PATTINSON in the chair.

"On the Variation in the Composition of Steel Forgings." By T. W. HOOGE.

Having some time ago made a series of analyses in order to ascertain whether there was any difference in composition between the centre and the surrounding material of a steel forging, and as these analyses are connected with a subject which has already attracted some attention, they have been connected together in the form of this short paper.

Although most of the following experiments were made about the time Mr. Stubbs, of Manchester, directed attention to this subject, I wish to submit them, as far as regards his observations on the sulphur, phosphorus, carbon, and silicon, as an independent corroboration of his work, by an indirect method of experiment.

In the first of these experiments advantage was taken of an opportunity which offered itself of examining an old waste steel forging which had been made from an ingot containing impurities in considerable proportion. The diameter of this forging was 7½ inches. It was formed from an ingot of about three tons in weight. A section having been cut out from this forging, borings were obtained from five points at equal intervals upon the face of it, as in figure.

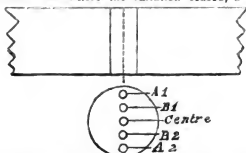
Analyses were made of the borings thus obtained, and the results are given in the following table, the marks corresponding to those in the sketch. In these and in all

the following analyses the greatest care was taken to obtain perfectly comparative results:—

| | A.1. | B.1. | C. | B.2. | A.2. |
|----------------------------|-------|-------|------|------|-------|
| Manganese | 0.87 | 0.88 | 1.08 | 0.88 | 0.86 |
| Carbon (by combustion) .. | 0.67 | 0.66 | 1.20 | 0.64 | 0.66 |
| Carbon (by colour test) .. | 0.56 | 0.52 | 1.00 | 0.55 | 0.55 |
| Silicon | 0.14 | 0.13 | 0.18 | 0.14 | 0.12 |
| Sulphur | 0.11 | 0.09 | 0.24 | 0.11 | 0.10 |
| Phosphorus | 0.062 | 0.045 | 0.15 | 0.06 | 0.061 |

Total 1.852 1.805 2.85 1.83 1.801

thus showing that there existed in this particular specimen a remarkable accumulation of impure metal in the centre. In order to find where the variation ceased, a further



series of analyses was made of drillings taken from a similar section of the same forging at distances from the centre of $\frac{1}{2}$ inch, $1\frac{1}{2}$ inch, $2\frac{1}{2}$ inch, and $3\frac{1}{2}$ inches respectively.

| Distance from the centre | $\frac{1}{2}$ in. | $1\frac{1}{2}$ ins. | $2\frac{1}{2}$ ins. | $3\frac{1}{2}$ ins. |
|----------------------------|-------------------|---------------------|---------------------|---------------------|
| Manganese | 1.0 | 0.94 | 0.88 | 0.85 |
| Carbon (by combustion) .. | 0.87 | 0.66 | 0.66 | 0.68 |
| Carbon (by colour test) .. | 0.72 | 0.56 | 0.56 | 0.55 |
| Silicon | 0.15 | 0.15 | 0.13 | 0.14 |
| Sulphur | 0.15 | 0.11 | 0.8 | 0.10 |
| Phosphorus | 0.11 | 0.06 | 0.06 | 0.07 |

Total 2.28 1.92 1.81 1.84

These results show that the impure metal is contained within a radius from the centre of $1\frac{1}{2}$ inch. More interesting information might have been obtained from borings taken from small drill holes and at small distances from each other, but the quantity of material so obtained is insufficient for analysis.

This difference in the composition is accompanied by characteristic differences in the appearance of the borings themselves; those obtained from the centre of the forging being very brittle and in colour very dark:—whilst those coming from the parts marked A 1, A 2, B 1, and B 2, no essential difference from ordinary medium steel drillings is apparent.

Such a variation in the composition of this particular forging having undoubtedly taken place, it seemed interesting to ascertain whether ordinary steel forgings would be liable to the same action. For this purpose samples cut from five ordinary steel forgings were obtained. From each of these samples borings were taken from the centre, and also at a point about $1\frac{1}{2}$ inches from the outside surface. These last (as shown by the analyses given above) will fairly represent the material surrounding the centre.

The analyses of these specimens are given in the following tables:—

1ST SAMPLE.—A FORGING $5\frac{1}{2}$ INCHES DIAMETER, AND FORMED FROM AN INGOT WEIGHING ONE TON.

| | Centre. | Surrounding Material. |
|-------------------------|---------|-----------------------|
| Manganese | 0.58 | 0.48 |
| Combined carbon | 0.39 | 0.29 |
| Silicon | 0.047 | 0.015 |
| Sulphur | 0.11 | 0.041 |
| Phosphorus | 0.08 | 0.059 |

Total 1.207 0.885

Thus showing an increase of 0.3 per cent at the centre.

2ND SAMPLE.—A FORGING $7\frac{1}{2}$ INCHES DIAMETER, AND FORMED FROM AN INGOT WEIGHING $3\frac{1}{2}$ CWTs.

| | Centre. | Surrounding Material. |
|-------------------------|---------|-----------------------|
| Manganese | 0.43 | 0.41 |
| Combined carbon | 0.24 | 0.14 |
| Silicon | 0.01 | 0.02 |
| Sulphur | 0.11 | 0.039 |
| Phosphorus | 0.07 | 0.048 |

Total 0.86 0.657

Impure metal is, therefore, present at the centre.

3RD SAMPLE.—A FORGING $7\frac{1}{2}$ INCHES DIAMETER.

| | Centre. | Surrounding Material. |
|-------------------------|---------|-----------------------|
| Manganese | 0.36 | 0.37 |
| Combined carbon | 0.37 | 0.37 |
| Silicon | 0.031 | 0.023 |
| Sulphur | 0.064 | 0.053 |
| Phosphorus | 0.06 | 0.06 |

Total 0.885 0.876

This specimen, therefore, is homogeneous in its composition.

4TH SAMPLE.—A FORGING $7\frac{1}{2}$ INCHES DIAMETER.

| | Centre. | Surrounding Material. |
|-------------------------|---------|-----------------------|
| Manganese | 0.53 | 0.43 |
| Combined carbon | 0.60 | 0.45 |
| Silicon | 0.13 | 0.10 |
| Sulphur | 0.096 | 0.05 |
| Phosphorus | 0.07 | 0.045 |

Total 1.426 1.075

Thus again we see that there is impure metal at the centre

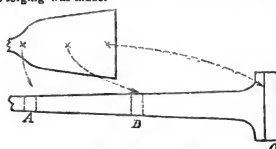
5TH SAMPLE.—A FORGING $12\frac{1}{2}$ INCHES DIAMETER.

| | Centre. | Surrounding Material. |
|-------------------------|---------|-----------------------|
| Manganese | 0.27 | 0.25 |
| Combined carbon | 0.38 | 0.39 |
| Silicon | 0.023 | 0.054 |
| Sulphur | 0.060 | 0.062 |
| Phosphorus | 0.041 | 0.041 |

Total 0.774 0.797

This affords an example of a section of a forging homogeneous in its composition.

Here then are three out of the above five examples showing that the action indicated in the first series of analyses takes place even in an ingot one ton in weight, and two examples where the steel is practically homogeneous in composition. No explanation of this difference in the results suggested itself for some time until an opportunity occurred of obtaining cuttings from a forging. These cuttings corresponded to the part near the top, middle, and bottom respectively, of the ingot from which the forging was made.



The figure will make clear the position of the samples from which the following analyses were obtained, the

borings being taken as in the above samples, namely, at a point 14 inches from the outside surface and at the centre:—

(a.)—Section corresponding to the part near the top of the ingot:—

| | Centre. | Surrounding Material. |
|--------------------|---------|-----------------------|
| Manganese | 0.70 | 0.67 |
| Combined carbon .. | 0.36 | 0.30 |
| Silicon | 0.10 | 0.10 |
| Sulphur | 0.06 | 0.046 |
| Phosphorus | 0.061 | 0.052 |
| Total | 1.281 | 1.228 |

(b.)—Section corresponding to the part near the middle of the ingot:—

| | Centre. | Surrounding Material. |
|--------------------|---------|-----------------------|
| Manganese | 0.80 | 0.70 |
| Combined carbon .. | 0.56 | 0.37 |
| Silicon | 0.12 | 0.10 |
| Sulphur | 0.14 | 0.05 |
| Phosphorus | 0.12 | 0.054 |
| Total | 1.74 | 1.274 |

It is, therefore, found that in this part of the forging there is a considerable accumulation of impure metal.

(c.)—Unfortunately this sample was not from the same forging as the above, but was obtained from a similar one. It was 22 inches in diameter, and had received very little hammering, as will be evident from the sketch.

| | Centre. | Surrounding Material. |
|--------------------|---------|-----------------------|
| Manganese | 0.52 | 0.38 |
| Combined carbon .. | 0.40 | 0.40 |
| Silicon | 0.031 | 0.031 |
| Sulphur | 0.038 | 0.036 |
| Phosphorus | 0.064 | 0.061 |
| Total | 1.053 | 1.108 |

The manganese in this piece is slightly lower in the centre, otherwise the piece is quite homogeneous.

Another sample corresponding to the bottom of a similar ingot was obtained which had received a great deal of hammering, it being reduced to a diameter of 7 inches. This piece was examined at the centre of each end, and at a point 14 inches from the outside surface of one end only. The three analyses were practically alike, showing the perfect homogeneity of the piece.

These analyses, therefore, show that those parts of a steel forging corresponding to the part near the top and bottom ends of an ingot are homogeneous in their composition, and those parts of the forging corresponding to the middle of the ingot contain a core of accumulated impure metal, the extent of this accumulation depending upon the size of the ingot and the rate at which it cools.

This conclusion also follows from the observations of Mr. Stubbs, who, in addition, finds the impure metal to be nearer the top end of the ingot.

It does not seem probable that the existence of this slightly impure metal in the centre of a large forging can have any harmful influence upon it; but the fact should not be forgotten in the forging of large ingots to be cut up into billets for the production of the smaller articles in steel, for amongst these billets there will necessarily be some of very variable character. Of course this liability to vary will be reduced to a minimum by casting the ingots of as small dimensions as possible. In the analyses given about the samples corresponding to the top, middle, and bottom of the ingot respectively, the section corresponding to the top is shown to be practically homogeneous. The following analyses made in the same manner upon gits cut off from large castings corroborate this; the metal probably solidifies before any accumulative action can take place:—

GIT 8 INCHES DIAMETER FROM A STEEL CASTING.

| | Surrounding Material. | Centre. |
|--------------------|-----------------------|---------|
| Manganese | 0.62 | 0.62 |
| Combined carbon .. | 0.61 | 0.40 |
| Silicon | 0.39 | 0.44 |
| Sulphur | 0.045 | 0.048 |
| Phosphorus | 0.043 | 0.044 |

At the centre of this git part of the carbon had separated as graphitic or amorphous carbon which was not determined.

GIT 18 INCHES DIAMETER FROM ANOTHER STEEL CASTING.

| | Surrounding Material. | Centre. |
|--------------------|-----------------------|---------|
| Manganese | 0.46 | 0.41 |
| Combined carbon .. | 0.30 | 0.30 |
| Silicon | 0.25 | 0.25 |
| Sulphur | 0.053 | 0.057 |
| Phosphorus | 0.053 | 0.057 |

It is interesting to notice that Chernoff many years ago proved the structural inferiority of the upper ends of large ingots, even in those which have been submitted to considerable compression; so that the forging, through the hammering it has received, may appear to be quite sound, and the analysis may indicate the chemical homogeneity of it, yet it will be greatly inferior to the part corresponding to the bottom of the ingot. Advantage may be taken of this fact, and material may be obtained for special purposes from the bottom part of the ingot, homogeneous both in structure and in composition.

Attention may be drawn towards the fact that the manganese in these analyses increases with the other elements and does not decrease with the iron; but Mr. Stubbs concludes, and recently Mr. Snelus confirms his conclusion, that in the ingot itself the reverse is the case.

As was mentioned at the commencement of the above analyses, the greatest care was taken to make the results strictly comparative. However, in order to satisfy myself of the accuracy of these comparative determinations, three separate analyses were made upon different quantities of the steel from the centre and from A 1 (first series of analyses), these analyses being made by three different modifications of the ordinary acetate method. The results were:—

| | A. | B. | C. |
|------------------------|------|------|------|
| Borings from centre .. | 1.10 | 1.08 | 1.06 |
| Borings from A 1 .. | 0.90 | 0.87 | 0.88 |
| Increase in the centre | 0.20 | 0.21 | 0.18 |

It is to be hoped that those having an opportunity of repeating these experiments will carefully examine this point in connection with the manganese.

In conclusion, I have to thank Messrs. J. Spencer and Sons for their permission to communicate these analyses

The CHAIRMAN—The paper is very interesting as confirming the results of Mr. Stubbs and Mr. Snelus. I was at the meeting when Mr. Stubbs made his remarks, and it recalled some experiments which I made several years ago on pig-iron with a similar object. I took samples from the top and bottom of a large ladle containing pig-iron, and determined the impurities in each, paying especial regard to the phosphorus. I failed to find any difference between the two; but, of course, I was dealing with a very different material from steel (containing about 1.5 per cent. instead of about 0.05 per cent. of phosphorus), and our methods of determining phosphorus were not then so delicate as they are now. Mr. Stubbs showed that in the long vertical ingots which they cast the impurities seemed to concentrate in a small part near to the top of the ingot; those parts which cool quickly seem to be tolerably homogeneous. Mr. Snelus has pointed out a remarkable confirmation of these results in some experiments at Wool-

which, in which it was shown by the tensile strain and other mechanical tests that those portions of the ingots where the impurities tend to concentrate were of inferior quality to the rest. Since Mr. Snelus's discovery of the principle on which phosphorus can be eliminated from pig-iron in the Bessemer converter, still further developed by Messrs. Thomas and Gilchrist and others, the great principles of dealing successfully with the impurities of pig-iron have been mastered. With such experiments as Mr. Hogg has laid before us we are now getting into the refinements of steel manufacture. They are of great value in increasing our knowledge of the properties of this valuable metal, and in throwing light on some of the causes of unexpected failure in steel plates and other large masses of steel.

A vote of thanks to Mr. Hogg terminated the proceedings.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

December 5, 1881.

MR. ROBERT R. TATLOCK, President, in the Chair.

Dr. Wallace's Address.

(Concluded from p. 33.)

WE now come to a division of our subject which is not chemical but physical, but which is nevertheless closely connected with the dissociation of compound bodies. We have in nature three states of matter—solid, liquid, and gaseous; but these are merely accidental conditions, as I shall attempt to show you, determined partly by the nature of the bodies themselves, partly by the particular temperature and pressure to which they are subject. I think you will have no difficulty in accepting the axiom that all solid bodies are capable of being liquefied, if we except a comparatively small number which pass at once from the solid to the gaseous state, such as metallic arsenic, some of the compounds of arsenic and of mercury, &c. Platinum, which resists the heat of our ordinary furnaces, melts like wax before the oxy-hydrogen flame; and in a crucible of pure lime—as suggested by Deville, and wrought out practically by Johnston, Matthey, and Co., of London—pounds, I might almost say hundredweights, of it can be fused with as great facility as the plumber melts lead in an iron ladle over a chaffeur. Iridium, which is more refractory than platinum, may be melted also by the oxy-hydrogen flame; and all metals, without exception, cease to retain their solid form when placed in a voltaic circuit of such quantity and intensity that they cannot pass it without resistance. We are familiar with one liquid metal, mercury; but at a temperature of -40° F. it is a malleable solid, not unlike lead; while at 560° F. it is gaseous and indistinguishable in appearance from air or any other gas. Again, we are equally familiar with metals—potassium and sodium—which are soft to the touch, and can be cut with a penknife with the greatest facility. They are, in fact, at the temperature of this earth, in the plastic condition to which iron is reduced when brought up to a welding heat, and which platinum assumes far below its point of fusion. These metals, which when cut have the brilliancy of the most highly-polished silver, melt below the temperature of boiling water (136° and 190° F.), and become hard when exposed to intense cold. Tin melts at a comparatively low degree of heat (442° F.), so do lead and zinc (617° and 773° F.)—the latter assuming, a little below its melting-point, a brittle condition, in which it may be reduced to powder in a mortar, while a little lower (300° to 300° F.) it assumes a highly malleable state, in which it is readily rolled into the sheets with which we are all familiar. It is worthy of note that many metals and other solids in melting contract in bulk, and in solidifying expand. Thus, ice floats on the top of water, having a gravity, as compared with water=1000, of 920. It was at one time supposed that water in this respect occupied

an anomalous position, but recent experiments—some of them made by members of this Society—have conclusively shown that in a great many cases, when the solid form of the body is at or near the temperature of its liquid condition, it floats on the surface in consequence of its lesser gravity. It is true that a cold pig of iron, thrown into a molten mass of the same metal, will sink to the bottom of the vessel, but as it becomes assimilated in temperature to the liquid metal it rises to the surface. A similar experiment made with trap rock shows that, in this case also, there is contradiction in fusing the mineral and expansion in cooling the fused mass. In like manner we could, by exposing ice to an intensely low temperature—thus, contracting its volume and increasing its relative density—cause it to sink in water, which might be heated to decrease its specific gravity. The explanation of this phenomenon is probably that, in assuming the solid state, the atoms or molecules take a geometric form, in which they occupy more space than they do when in a free condition of molecular movement, as they are when in the liquid state.

All liquids are capable of being boiled or converted into gases or vapours by heat, the only exceptions being in the case of those compounds which, on being heated, suffer decomposition. It is equally the case with solids, with the same exception, so that the gaseous form may be regarded as the normal condition of matter. There are many solid bodies which we have not actually as yet converted into gas, and we are compelled to fall back on analogies for proof of our proposition. The liquid metal, mercury, can be distilled like water, although the temperature required is considerably higher; potassium and sodium are converted into vapour with almost equal facility, and zinc is regularly distilled in the commercial production of that metal from its ores. Lead also is distinctly volatile, and no metal, however refractory, can be kept long at its melting-point without suffering some loss of weight. Iron is readily volatilised in part by the heat generated by its own combustion in oxygen gas. Arsenic on being heated sublimates, passing at once into the gaseous condition without assuming the liquid form. Gold, which requires a rather high temperature for fusion, is at once dissipated in the gaseous state by an electric discharge of high tension and silver, platinum, copper, iron, and many other metals are vapourised instantaneously with equal facility. With regard to carbon, there can be little, if any, doubt in the minds of scientific men that it is converted into vapour in the electric arc, and that without necessarily undergoing combustion, for the phenomena are not sensibly altered when the experiment is made in an exhausted receiver, or in a vessel filled with an inactive gas, such as nitrogen. It may be said that the transference of carbon from the one pole to the other is simply mechanical, and consists of solid particles detached from the one and carried to the other; but that explanation does not suffice to account for the observed facts, and we are driven irresistibly to the conclusion that there is a partial volatilisation of the carbon. The chemist talks of compounds, such as marsh gas and carbonic oxide, as containing so many volumes of the other elements; but I need scarcely say that the combining volume of carbon is deduced, on theoretical grounds, from the volume of its compounds and comparison with analogous cases. Still, that carbon is capable of existing in the free state as a gas or vapour will scarcely be disputed. So with all other elements, and so with all chemical compounds, with or without previous re-solution into their constituent elements. What we cannot prove by experiment we must still accept as the only rational conclusion to which we are led by analogy and reasoning.

We now come to the converse view of the matter. Most liquids can readily be made to assume the solid form. There are, it is true, some organic liquids—of which alcohol may be taken as a type—which have never yet been frozen; but even in these cases we have seen the liquids assume, in the extreme rigour of an Arctic winter, an oily consistency, which is no doubt an approach to the solid form which would be attained by the application of

a temperature sufficiently low. As regards the gaseous condition, the treatment of the subject requires a little more consideration. Formerly we were in the habit of speaking of *permanent* gases as distinguished from others which had liquefied, such as sulphurous and carbonic anhydride, chlorine, cyanogen, and so on; and we also spoke of the vapours of water, alcohol, mercury, and other volatile liquids as if they were something different from gases. All that has been changed by the splendid experimental researches of Caillaud and Pictet, by whom the so-called permanent gases—oxygen, hydrogen, and nitrogen—have been liquefied. In the case of hydrogen, which has long been considered to fulfil the functions of a metal, it was liquefied by Pictet under a pressure of 650 atmospheres, or upwards of 4 tons on the square inch,* and a temperature of -170°C , or -274°F ; and, in escaping from its confinement, the further reduction of temperature caused by its re-assumption of the gaseous state sufficed to solidify a portion of the liquid, and the particles fell to the floor, to quote the experimenter's own words, with "the shrill noise of metallic hail." Hydrogen, or, as we should perhaps call it for the sake of uniformity, hydrogenium, is really a metal after all, and it is only an accident of temperature and pressure that prevents it from possessing the ordinary metallic properties with which we are familiar in lead, silver, or platinum.

The difference between solids, liquids, and gases is simply a question of temperature, or, in other words, of molecular motion. In liquids and gases we have, according to the generally accepted kinetic theory, a constant movement of the atoms or molecules, the rate of which differs in the case of each individual gas. It is difficult to define the exact difference between gases and liquids; both possess, to a very large extent, the same functions, and many gases can be converted into liquids by pressure alone, and independently of reduction of temperature. In like manner, if we place a liquid in a confined space and seal it up we can convert it entirely into gas by exposing it to a sufficiently high temperature, provided there is enough space for the expansion of the liquid before it is converted into gas. A cubic inch of water becomes, under ordinary circumstances, a cubic foot of steam or gaseous water; but the water may be converted into gas in a confined space of less than two cubic inches. Many of the experiments on the relations of gases to liquids have been conducted with carbonic anhydride, which, under ordinary temperatures, is liquefied under a pressure of about 50 atmospheres. The researches of Andrews, of Belfast, are particularly noteworthy, and are well known to all physical and chemical philosophers. He was the first to observe what is called the "critical point" of a liquefiable gas, a point at which it is difficult to say whether the body exists as gas or liquid; or, rather, we may have both forms existing in the same vessel, but without any distinct line of separation—in fact, they seem to merge into one another. The critical temperature varies with the pressure, and in some gases it is far below zero of Fahrenheit's thermometer. Still, under ordinary circumstances, the physical characters of gases and liquids are sufficiently well marked, besides which we have in the change of state from liquid to gas a large amount of heat rendered latent, and in the contrary action a similar amount of heat becoming sensible.

It is, perhaps, superfluous to dwell further on this interesting subject; but I would like to impress this fact on your minds, that the atoms of matter are the same whatever be the physical condition. In solids, as I have already hinted, the atoms are probably arranged in molecules of symmetrical geometric form. The simplest geometric form is the tetrahedron, in which case only four atoms would be required to form a molecule; but probably there are few molecules so simple, and there is reason to believe that many of them are highly complex, especially the molecules of compound bodies. Crystalline forms,

such as we produce by fusion and cooling, by solution and evaporation, or by sublimation, are probably aggregates of the symmetrical molecules; at least we know that some crystals, such as those of Iceland spar, are built up of myriads of smaller crystals of exactly the same form. There are many solids which have two or more distinct forms, which often possess specific properties. Sulphur is one of them; it has at least two distinct crystalline forms, and one that is amorphous. In these various modifications we can readily conceive that the atoms in the molecules are differently arranged, and probably different in number, and that in the amorphous state symmetry is absent, and the atoms are not grouped into molecules, but are free and distinct as in liquids, although destitute of motion. Silica affords an excellent illustration of trimorphism. There is the familiar variety known as rock crystal, the form of which is a six-sided prism, and it has a gravity of about 2.6. Another crystalline form, "Tridymite," has a gravity of 2.3, while the ordinary amorphous quartz is only 2.2. All these modifications may be formed by deposition from solutions, but at different temperatures. Sometimes one crystalline form may be transformed into another by the simple application of heat, and the change becomes apparent by some modification of colour or some other property. Thus the scarlet iodide of mercury, when gently warmed, acquires, together with a new crystalline form, a pale yellow colour, which gradually and slowly comes back to the normal tint, which may be more rapidly brought back by friction. Again, the brick-red double iodide of mercury and copper changes to black at the temperature of boiling water, the red colour being restored on the removal of the source of heat. Calcic carbonate has two very distinct crystalline forms, one of which, the rhombohedron, is well known in the mineral form of Iceland spar; the other, a six-sided prism, is seen in aragonite. Now, if a crystal of aragonite is suddenly heated, it falls into a rough powder, which, on examination with a microscope, is seen to consist of minute crystals of Iceland spar.

In liquids and gases we may assume, with some degree of probability, that the atoms are in most cases not grouped into molecules, at least in the case of elementary bodies. In these two forms of matter the atoms are in motion, but the motion is more rapid in gases than in liquids, in the former having what is called a free path, in which they move a considerable distance, compared with their own dimensions, without encountering one another; while in the latter they are constantly coming into collision. The great difference between liquids and gases is that in gases, unless at or near the critical point, the atoms are further apart than in liquids, other circumstances, as of pressure and temperature, being equal. In the case of hydrogen gas, at ordinary temperature and pressure, it has been calculated that the atoms move at the rate of 6225 feet per second, their size being at most $1\frac{1}{2}$ millionth of an inch in diameter. The rate of motion, however, is influenced both by temperature and pressure.

The atoms of gases are inconceivably minute, and the distances between them, although necessarily very far in excess of the dimensions of the atoms themselves, are also infinitely beyond our powers of perception. In regard to water, we cannot tell the absolute distance of the atoms in steam, but we know this much, that they are twelve times farther apart in every direction than they are in water—a cubic inch of water giving a cubic foot of steam. But gases are different from solids and liquids in being infinitely more readily affected by temperature and pressure. They possess the property of idio-repulsion, which causes their atoms to separate further and further as the pressure is reduced. I am not sure that there is really such a force as idio-repulsion, but it is true, at all events, whatever be the correct explanation of it, that as the pressure decreases the volume increases, and this without any apparent limit. It has been argued that, if matter consists of atoms, it follows that gases have a limit of expansion, beyond which they cannot pass. But it has

* It will assist the comprehension of this enormous pressure when stated that it is equal to that exerted by a rod of iron 2900 ft. high.

really nothing to do with the atomic theory, for it is not a question of the infinite divisibility of matter or the reverse, in regard to which there is at the present day no manner of doubt in the minds of chemists and physicists, but simply of the separation of atoms further and further apart. In the experiments of Gassiot and Crookes, gases have been reduced to a most extraordinary degree of tenuity, and perfect vacua have been obtained—perfect, at least, as regards the particular gases with which the vessels were filled, the last traces being absorbed by chemical agents. For my own part, I cannot conceive of any limit to the distance to which the atoms of a gas may be separated, any more than I can conceive of a limit to space itself. In regard to the atmosphere which surrounds our earth, it probably becomes so attenuated at a distance of about forty miles as to be scarcely appreciable in gravity; but there are really no good grounds for supposing that it is limited to 40, 50, or even 200 miles, or that it does not in some degree fill all space, at least within our solar system. But it is impossible to stop here; if this is so, it follows, almost as a matter of course, that the same space contained at one time—a distance of time that it is as impossible for us to realise as it is for us to form a distinct conception regarding the dimensions of space itself—all the elements which we find on the earth's surface, in the planets, in the comets belonging to our system, and in the sun.

It is well known that, if we descend into the earth we soon reach a point at which the temperature is practically constant, affected, to an appreciable extent, neither by the heat of summer nor the cold of winter. This point of constant temperature varies in different parts of the world, but in this country it is about 50 feet from the surface, and is about 47° F. But, if we descend beyond this point by means of a pit or mine, we find a decided increase of temperature the further we descend; and this increment of heat goes on to the greatest depths which have been reached, either by actual descent into the bowels of the earth, or by boring for water to still greater depths. The rate of increment varies at different places from 50 to 100 feet for each degree Fahr. It is, therefore, a natural conclusion that there exists an internal source of heat, which is constantly passing outwards and being dissipated into space. The existence of volcanoes, and of rocks which bear unmistakable evidence of having been in a state of fusion, point to the same conclusion; and it is only a further step to understand that the earth was at a former period in a complete state of fusion, and that it has been gradually cooling ever since. With regard to the question whether there is an internal mass of fluid towards the earth's centre, that is a matter which is open to discussion, and which cannot be determined by actual observation. If the increment of heat which we find in descending some hundreds of feet in a pit were continued at the same rate to a depth equal to only 1/50th of the earth's radius, or about 80 miles, nearly all bodies with which we are acquainted would be in a state of fusion. As regards volcanoes, there is at least a probability that their occurrence is due in many instances to local causes, and that they are not necessarily connected with an internal igneous mass. In passing, I will only make this one observation in regard to the geology of the earth's crust, that some of the rocks which were formerly considered to be of igneous origin, have, upon further study, been declared to have been deposited from water. Even the granite, which Murchison used to speak of as the backbone of our native land, must, I fear, be relegated to the group of metamorphic rocks, of which it is, however, probably the most ancient.

The earth at one period was a fluid mass, cooled gradually by radiation; and, after a time, a crust was formed on its surface. But as this crust, itself a very bad conductor of heat, grew colder towards the surface, contraction must have taken place, and irregular fissures produced, giving rise to catastrophes of various kinds, and especially the formation of mountain ranges. Neither

can we suppose that the fluid mass was perfectly quiescent: on the contrary, there is every reason to suppose that chemical action was going on, giving rise to the formation of gaseous matter, which found vent in the craters of volcanoes. In course of time the earth became so cold that the aqueous vapour contained in the atmosphere condensed, and a new series of phenomena commenced, one result of which was extensive deoxidation and the formation of the sedimentary rocks, some of which must have been formed at inconceivably remote periods. The upheavals of the earth's crust, to which I have referred, certainly continued long after the condensation of water, for we find sedimentary rocks high up in the most lofty of our mountain chains; and they occur even at the present time, although in a modified form, and only in certain circumscribed localities.

But, remote as the period of perfect fluidity undoubtedly was, it is a fair and legitimate conjecture, if I may use that word in regard to a matter which scarcely admits of a doubt, that it was preceded by one yet further removed in the dim vista of the immeasurable past. It is true that we are absolutely incapable of contemplating a commencement of the existence of the universe, just as we cannot conceive of the beginning of time, the duration of eternity, or the bounds of space; but if we follow up the thoughts in which we have been indulging, we seem to come unavoidably to a period in which that form of motion which we call heat reigned supreme, in which all matter was gaseous and elementary. How that matter came to be condensed and aggregated into groups, forming a central sun, planets and their satellites, comets, aerolites, and meteoric dust, I shall not attempt to conjecture; but I shall ask you to follow me in a speculation which I trust you will not consider too daring or presumptuous. The cooling effect of radiation on these aggregations of vapours would probably result, in the first place, in the chemical union of the various elements, especially the metals and hydrogen, with oxygen; and as this combination would set free heat formerly latent in the elementary bodies, there would, for a long time, be a period of oscillation between compounds and elements, during which the cooling process would go on with extreme tardiness. Merging imperceptibly into this period of chemical combination would be that of liquefaction of the compounds and the few elements, such as gold and platinum, which possess only slight affinities for the other elements; with a residuum of oxygen and nitrogen gases, and steam more or less mixed with other vapours. Then would follow a period of comparative quiescence; combustion, that is, the combination of the elements, would cease, and enormous contraction in bulk would follow, and the orb would be, to use a vulgar phrase, played out as a source of light to surrounding heavenly bodies, and would soon become covered with a solid crust, which would render it comparatively inoperative as a centre of heat radiation. There would follow the various phenomena which I attempted to describe as having been experienced in our own little planet; and, if we were to pursue the speculation further still, we should reach a point in the future as dim and distant as the events I have alluded to were in the past, in which sun, earth, and moon, not to speak of the innumerable suns belonging to other systems with which the sky is studded, will be cold and lifeless as the impenetrable ice-barriers of the Polar regions. But surely these are not mere speculations; are they not going on before our eyes at the present time? Is not our own earth in the stage of cooling down after having completed its period of active incandescence? and is not the sun at this very moment undergoing the combination of its elements which has gone on for ages, and will go on for ages to come? What are the solar prominences but gigantic flames of hydrogen in the act of combination with oxygen, and the photosphere but an almost transparent film of gaseous matter undergoing combustion; while the nucleus is still composed of matter at too high a temperature to admit of chemical combination between its elements? And is not

the chromosphere, which gives us the Fraunhofer lines in the solar spectrum, the gaseous or vapourised products of combustion of hydrogen and the various metals which in the body of the sun exist as gases, but condensed to comparatively small bulk by enormous pressure?

The gravity of the earth is about 56, which is about twice that of granite, and $\frac{1}{3}$ that of trap rock. The weight of the sun, as compared with water, is only one-fourth that of the earth; and as the constituents, as determined by the spectroscopic, are essentially the same, while the effects of gravitation are enormously in excess of those observed on the earth's surface, it is a fair inference to conclude that when, in future and far distant ages, the heat generated by the combination of its elementary constituents, and that derived from the changes of state from gas to fluid and from fluid to solid, will have been dissipated into space, its bulk will have so far contracted that its gravity will at least equal that of the earth.

Gentlemen, the subject of chemical dissociation, to which I essayed to call your attention this evening, has led me imperceptibly to treat of matters which have long been floating in my mind, but to which I have not hitherto ventured to give expression; and I have to crave your indulgence for the exceedingly crude and imperfect way in which I have placed these views before you, and also for having failed to notice other theories which have been advanced for the explanation of the phenomena of solar heat and light. We live in a time of rapid progress in scientific research, and talk familiarly of matters of momentous import, which our fathers never dreamt of. Let us see that we are not puffed up with our knowledge—which, after all, is trifling compared to what mankind may yet attain to—but ever struggle on, humbly and hopefully, in the earnest desire to learn something of the mysteries of that glorious world in which we are such insignificant units.

A very interesting discussion followed, in which Mr. Macfar, Dr. Dobbie, Mr. Whitelaw, Mr. Stanford, Mr. Coleman, and Mr. Mayer took part.

A hearty vote of thanks having been proposed to Dr. Wallace, the meeting closed.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xx., Part 3.

The Separation of Cadmium.—E. Donath and J. Mayrhofer.—The statement of Ditté that cadmium sulphide is appreciably soluble in ammonium sulphide is unfounded. Cadmium sulphide precipitated with ammonium sulphide passes even through a double filter. Hence sodium sulphide should be used if cadmium is present.

New Reaction for the Detection of Sulphur and Nitrobenzol.—R. Brunner.—The substance to be examined is mixed with a little strong potassa-lye, a few drops of commercial nitro-benzol and of alcohol are added, and the mixture is allowed to stand at the common temperature, with occasional stirring. After some time, if sulphur or an alkaline sulphide is present, there appears a red colouration, due to the reduction of nitro-benzol. In this manner, both free sulphur and the sulphur present in white of egg, in bread, wool, &c., may be directly demonstrated. An inversion of the process may serve for the detection of nitro-benzol.

Detection of Small Quantities of Cobalt and Nickel, simultaneously present.—E. Donath and J. Mayrhofer.—The precipitate obtained in a systematic

analysis which may consist of nickel and cobalt sulphides is dissolved in a minimum of nitric acid, mixed with an excess of soda-lye, and a corresponding quantity of solid iodine, and boiled. If little nickel and much cobalt are present the precipitate is brown or brownish black, granular, and loose. In the opposite case it is either like pure nickelous oxide or of a dirty greyish green; it is filtered, washed with hot water, and introduced into a test-tube by perforating the filter. Here it is shaken up with ammonia and a few drops of ammonium chloride solution and filtered. The filtrate, which can only contain nickel, is mixed with a few drops of ammonium sulphide. An immediate dark brown colouration followed by a black precipitate, shows the presence of nickel. The residue upon the filter is several times drenched with ammonia, thoroughly washed with hot water, dissolved in a few drops of hydrochloric acid, and the solution boiled with a fragment of solid potassa. After the precipitate has subsided, the blue colour of an alkaline cobaltate is observed, which is soon decomposed, with a deposit of brown cobalt oxide.

The Ash of Coke.—A. Wagner.—A reply to a paper by Dr. Muck, in which the latter attributes to the author views which he entirely disclaims.

A New Test for Potassa.—L. L. de Koninck.—If a 10-per cent solution of sodium nitrite is mixed with cobaltous chloride and acetic acid, the liquid forms a reagent for the detection of potassa, much more sensitive than platinum chloride. An immediate yellow precipitate is obtained in a solution containing 1 part potassium chloride in 100 parts of water. It is still perceptible if diluted to 1:1000, but in the proportion 1:2000 a precipitate is no longer obtained. Ammonia gives a similar but much less sensitive reaction; the salts of magnesium, calcium, barium, strontium, iron, aluminium, and zinc are not precipitated by the reagent. The author is endeavouring to found a quantitative process upon this reaction.

Determination of the Specific Gravity of Liquids.—L. Weber.—The author takes two U-tubes of equal weight, each with a short and a long limb, connects the two short limbs by means of a caoutchouc tube, and pours into one of the long limbs water, and into the other the liquid to be examined. The liquids stand higher in the long than in the short limbs, and the difference of level will be inversely as the specific gravities.

Behaviour of Platinum Crucibles on Ignition.—H. Beilstein.—New crucibles suffer a greater or less decrease in weight when heated, but after repeated ignition such changes no longer occur.

Preparation of Hydriodic and Hydrobromic Acids.—C. Winckler.—The author uses a solution of iodine in carbon disulphide. Over this is a stratum of water, and hydrogen sulphide is introduced as usual. The method is applicable for hydrobromic acid, but with less distinct advantage.

Detection of Alumina.—M. Beckmann.—The author recommends baryta water in place of soda-lye, as not being contaminated with alumina and silica. Solution of ammonium chloride is added afterwards, as usual.

MISCELLANEOUS.

Popular Science.—In a morning paper for the 17th inst. we find a list of explosives mentioned as used on ship-board, among which figures one under the name of "sodium of calcium."

The Royal Society of New South Wales.—(*Original Researches.*)—The Royal Society of New South Wales offers a prize for the best communication, containing the results of original research or observation, upon each of the following subjects:—

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The competition is in no way confined to Members of the Society, nor to residents in Australia, but is open to all without any restriction whatever, excepting that a prize will not be awarded to a Member of the Council for the time being; neither will an award be made for a mere compilation, however meritorious in its way—the communication to be successful must be either wholly or in part the result of original observation or research on the part of the contributor. The successful papers will be published in the Society's Annual Volume. Fifty reprint copies will be furnished to the author free of expense. It is the intention of the Society to offer additional prizes should this first attempt to encourage original scientific investigation be reasonably successful.—A. LIVESIDGES and A. LEIBUS, Hon. Secs.—The Society's House, 37, Elizabeth Street, Sydney.

MEETINGS FOR THE WEEK.

- MONDAY, 30th.—London Institution, 5.
— Medical, 8.30.
— Society of Arts, 8. "Recent Advances in Photography," by Capt. W. de W. Abney, F.R.S.
TUESDAY, 31st.—Institute of Civil Engineers, 8.
— Royal Institution, 8. "The Mechanism of the Senses," Prof. J. G. McKendrick.
— Society of Arts, 8. "The Social and Physical Capacities of New Zealand for Tea and Silk Cultivation," by William Cochran.
WEDNESDAY, Feb. 1st.—Society of Arts, 8. "Stained Glass Windows," by Lewis Foreman Day.
— Pharmaceutical, 8.
— Obstetrical, 8. Anniversary.
THURSDAY, 2nd.—Royal, 4.30.
— Chemical, 8.
— Royal Institution, 3. "Corals," Mr. H. N. Moseley.
— Royal Society Club, 6.30.
FRIDAY, 3rd.—Royal Institution, 8. "Action of Molecules, Free and Constrained, on Radiant Heat," by Professor Tyndall, 9.
— Geologists' Association, 8. Anniversary.
SATURDAY, 4th.—Royal Institution, 3. "Ludwig van Beethoven," by Prof. Pauer.

TO CORRESPONDENTS.

R. Naman Edmayer.—A notice of the book on Coal appeared in the CHEMICAL NEWS, vol. xlv., p. 255.

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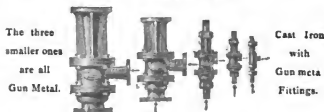
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THE CHEMICAL NEWS

Vol. XLV. No. 1158.

ON MANURE PHOSPHATES.

By K. WALTER, Chemical Engineer, Avelal, Belgium.

WHEN I wrote my last article on this subject in the *CHEMICAL NEWS*, vol. xxxviii., pp. 37, 50, I could not have imagined that it would take such a long time before the analysis of those phosphates by the method of citrate of ammonia would be generally adopted. The more, as I know, that the greater number of English agricultural chemists are convinced that the phosphoric acid soluble in the citrate, is equal in value to the phosphoric acid soluble in water.

Professor Petermann, in Gembloux, Chief Manager of the Belgian Royal Agricultural Stations, had in 1877 officially announced that from January 1, 1878, all the phosphoric acid soluble in the citrate of ammonia would be counted at the same rate as the former soluble in water. In short, any sample of superphosphate would no more be valued on its contents of phosphoric acid soluble in water, but only on its contents of phosphoric acid soluble in the citrate of ammonia. To this latter process was then given the term determination of *assimilable phosphoric acid*.

Neither manure manufacturers nor agriculturists made the slightest objection to this innovation, because everybody found himself well off by it; and to-day it has so much become the custom, that neither party appears to think that it has ever been otherwise. The more so, as the repeated trials of latter years have clearly shown the superiority of precipitated phosphate (retrograded phosphate) to the superphosphate. All the experiences of Toulie, Grandeau, Petermann, and many others, are, by the trials of late, confirmed to evidence.

As soon as the decision of Dr. Petermann was known, the German superphosphate manufacturers took up the matter, and tried with all their might to introduce the same system into Germany; but they found it not as easy as they had a right to believe. There were some eminent agricultural chemists who were perfectly of the same opinion as Petermann, and fought by word and writing for the same cause; but the greater number of them, including some of the most influential, were thoroughly against it.

The German Professors never could pardon Petermann, that he had taken, as one of them (Petermann is German), such a measure without first having demanded and obtained the high permission and assent of united sage agricultural Germany.

However, some of them were honest enough to begin to try the matter by experience, and at this period, even the most inveterate opponents of Petermann's system were obliged to come over. It was generally admitted that the phosphoric acid soluble in the citrate has at least the same value as phosphoric acid soluble in water, for those kinds of soils in which the experiments were made. They concluded that further experiments must show if the equality is evident in all kinds of soils.

Anyhow this was a great step forward—by which German superphosphate makers have profited. They have begun to count the phosphoric acid soluble in citrate—*en attendant*—at half the price, as that soluble in water. There can, however, not be the slightest doubt that in a time very near to come, the same system as used in Belgium and in France will be adopted in Germany; at all events, manure makers there do their utmost to bring things to this solution.

It is altogether inexplicable that the English manure

manufacturers—by far the most interested in this question—did not take serious steps to follow the same road. The quantities of superphosphate made by the English works is so very important that those manufactured on the Continent are a mere nothing against it. The English superphosphate manufactory loses annually hundreds of thousands of pounds by persisting in their present system—and this in times in which the chemical trade cannot afford to make any superfluous losses which easily might be avoided.

Every experienced superphosphate maker knows that even the purest raw phosphates (containing only traces of iron and alumina) give superphosphates, which contain $\frac{2}{3}$ to 1 per cent of phosphoric acid not soluble in water but easily in the citrate of ammonia. Most phosphates, however, used for the trade in question, give superphosphates containing in a fresh state 14 per cent of phosphoric acid not soluble in water but in the citrate. After storing of three to four months' duration, this latter amounts to 2 to 3 per cent, and sometimes even more—of course to the detriment of the phosphoric acid soluble in water.

If we take superphosphate, on an average, as containing 14.5 per cent phosphoric acid soluble in citrate, or 13 per cent phosphoric acid soluble in water, 14 per cent are lost for the English manufacturer. That is to say for the whole quantity of phosphoric acid rendered soluble for sale and available for agricultural purposes, to per cent. A manufacturer making per year 3000 tons of superphosphate actually loses about £1200 annually.

It is certainly no advantage for the agricultural chemists to exchange the handy analysis of phosphoric acid soluble in water, against the more complicated and tedious one of phosphoric acid soluble in the citrate.

They were, however, obliged to do it on the Continent, and the English chemists will have to follow, sooner or later. This mode of analysis has now arrived at such a perfection that the results of the different chemists, when they follow the same method, are most satisfactory, and just of the same accordance as the analysis of phosphoric acid soluble in water. In the International Congress of Agricultural Chemists, held at Paris last summer, the manner of analysis was fixed for the rest.

I will now narrate in a few words as possible the comparative results, given by a great series of trials in different parts of Belgium, Germany, and France, between the superphosphate monobasic phosphoric acid and the precipitated (retrograded, gone-back) phosphoric acid, considered to be bibasic; the first soluble in water, the second soluble in citrate of ammonia.

1. In heavy clay soils, the phosphoric acid soluble in water has the same effect as phosphoric acid soluble in the citrate, sometimes even a trifle better.
2. In soils rich in humus, limestone soils, stony soils the effect of the second is at least the same as that of the first.
3. In light, sandy soils, the effect of phosphoric acid soluble in water is surprisingly inferior to that of phosphoric acid soluble in the citrate.

In short, terms, the one is worth as much as the other as a general rule, but the intelligent farmer will take his choice in consequence of the soils he has to deal with. In the latter years experience has shown that in light, sandy soils, even precipitated phosphate dried at a very high temperature, and in consequence only containing traces of phosphoric acid soluble in the citrate, is by far superior in its action to superphosphate. I have likewise to remark that repeated trials have shown that phosphoric acid as precipitate is a little superior to phosphoric acid as it is in a retrograded state in the superphosphates, though both are soluble in the citrate. I attribute this difference in action to the different mechanical state of them, the precipitate permitting a finer division in the soil. The reason why monobasic phosphoric acid has in the most kinds of soils an action inferior to that one of bibasic phosphoric acid is easy to explain. In heavy

clay soils, the first one, the monobasic phosphoric acid, is put into solution by the water contained in the ground rather quickly, but is fixed immediately through the propensity of such soils to retain all kinds of salt solutions mechanically, and this in a very powerful manner. By and by it is transformed by the limestone, iron, or alumina in the ground into bisbasic phosphate of lime, iron, or alumina; and as such it is by slow degrees, according to the want of the plants, again put into solution by the carbonic acid, certain salt solutions, and even by the secretion of the roots themselves. The bisbasic phosphate has not to be transformed and is ready for action.

In light and sandy soils, the superphosphate is more or less lost; those soils, not having a very strong fining power, the rain washes its solution right through into the subsoil, before it has time to transform itself into bisbasic phosphate. This latter, however, put into the ground as such is only—being slowly soluble—put to profit by and by, just as the plants wanted it during their growth.

The consequence of those observations has been that phosphoric acid in the precipitate of lime is already paid at a little higher rate than phosphoric acid in the superphosphate in Belgium and the north of France. The demand far exceeds the production of the former.

The enormous loss of the English superphosphate makers is not the only drawback in this important question; a great resource of the English chemical manufacturing industry is likewise cut off by maintaining the present system. In England are actually great quantities of *muratic acid* running to waste, not to count those enormous quantities which are employed for bleach making. This latter article stands at present at a price which makes it hardly worth while to manufacture it, and many works use hydrochloric acid only for that purpose, because they are not allowed to let the acid run away.

England has equally great layers of natural phosphates, too poor to be employed for superphosphate making, but they are just the thing to serve as raw material for the manufacturing of precipitated phosphate, by means of the now useless quantities of *muratic acid*. With the progress this kind of manufacture has made in the latter years, it would be an exceedingly profitable one in England.

Of course, as long as precipitated phosphate has to be exported to bring its real value, no manufacturer will find it inviting enough to go in for it, though even for export it would very well be worth while to manufacture it; and once tried in England by some farmers it would make its way in no time, even if chemists and superphosphate makers cannot as yet make up their minds to introduce officially the citrate of ammonia analysis.

May these few lines tend to direct the attention of the leading chemical men and manufacturers in England to the important questions before named, and cause them to take serious and united steps for the welfare of the English chemical trade by following a system now in application for the past four years on the Continent.

A CHEMICAL ANOMALY.

M. SCHÜTZENBERGER has recently made a communication to the Chemical Society of Paris, which if confirmed will have an important bearing upon the fundamental principles of chemical science. Whilst pursuing his researches on the petroleum of the Caucasus, the author has not been satisfied with the results of his analyses, which, though made with the greatest care, frequently showed more than 100 per cent of matter. It is known that the ultimate analysis of such bodies is effected by burning a weight, P , of the substance in pure dry oxygen, and by weighing the quantities of water and carbonic acid which alone are formed in the combustion. The weights p of hydrogen and p' of carbon are deduced from the quantities

of water and carbonic acid found, and we ought to have $p + p' = P$.

For this calculation to be correct it is not necessary that the composition of water and of carbonic acid must be absolutely exact and constant; H_2O must contain precisely 16 parts of oxygen to 2 of hydrogen, and CO_2 must consist of 32 parts of oxygen to 12 of carbon. The best analysts of all countries have demonstrated that such is the fact. In the case of M. Schützenberger's analysis the weights p and p' of hydrogen and carbon, calculated for the formulae H_2O and CO_2 , are greater than P ; and he finds $p + p' = P + m$, without being able to find any change in the nature and purity of the products weighed.

As the Caucasian petroleum has been but recently studied, M. Schützenberger considered it necessary to verify the facts with other products. Pure aniline and benzol showed the same anomalies, yet there can be no doubt as to the composition of bodies which have been for years so completely studied; 100 parts of benzol, C_6H_6 , have given quantities of water and carbonic acid such that the sum of the weights of carbon and hydrogen present is = 101 to 101.5. All causes of error inherent in such analyses have been examined and discussed, and more than 150 experiments made.

The author has sought to prepare pure substances which should give 100 per cent, and others giving 101 per cent. In so doing he has made the curious observation that if Caucasian petroleum, aniline, and benzol are heated with sodium or copper, and distilled they acquire the property of giving more than 100 per cent on analysis, and retain it for a long time if kept in the dark. An exposure of two hours to the light was sufficient to cause a sample which had previously given 101 to 101.5, in a series of determinations, to show no more than 100 per cent. Thus sodium and copper would have the curious property of modifying certain substances without changing their apparent properties. The fact of the possibility of causing compounds to yield more than 100 per cent by the action of sodium, and restoring them to the normal state by the action of light, eliminates all errors due to weighings and manipulations: such errors would appear promiscuously in bodies whether modified by sodium or not. M. Schützenberger, without proposing any formal theory, suggests that the composition of water and of carbonic acid is not always what is supposed. It may also be that the weight of atoms varies within certain narrow limits.

If what we call an atom is merely the result of a vibratory movement of matter according to a certain law, this vibratory movement of the hydrocarbons may possibly be modified by that of sodium or by the luminous vibrations.—*Revue Scientifique* and *Les Mondes*.

RESEARCHES ON THE COMPLEX INORGANIC ACIDS.*

By VOLCOTT GIBBS, M.D.,
Rumford Professor in Harvard University.

(Continued from p. 31.)

PHOSPHO-MOLYBDATE.

24:1 *Croceo-cobalt Salt*.—The disposition of the cobalt-amines to form highly crystalline compounds, together with their well-defined and various degrees of basicity, led me to study the relations of these bases to the phosphomolybdic acids. This had already been done to a certain extent with the 5:1 atom series by Jørgensen, whose results I shall cite in connection with that series. Neither rosco-cobalt nor luteo-cobalt forms well-defined salts with 24:1 phospho-molybdic acid. I had therefore recourse to *croceo-cobalt*,† the oxide of which may be written—



* *Proceedings of the American Academy of Arts and Sciences* Communicated by the Author.

† *Proceedings of American Academy*, 10, 1.

The chloride of this series gives no precipitate with solutions of 7 : 3 ammoniac molybdate, or of hydro-disodic phosphate; but in an acid solution of these two salts a solution of the chloride throws down a beautiful bright yellow highly crystalline salt, which may be washed with cold water. The portion analysed was dried on woollen paper only. Of this salt—

1.0728 grm. gave 0.8133 grm. $\text{MoO}_3 + \text{P}_2\text{O}_5 = 75.81$ per cent.

1.4520 grm. gave 0.4719 grm. $\text{P}_2\text{O}_5 = 2.96$ per cent.

This corresponds to 72.85 per cent MoO_3 by difference, and 24.19 per cent of C_6O and water by the loss. The analyses agree very closely with the formula—



which requires—

| | Calc. | |
|----------------------------------|-------|--------|
| 24MoO ₃ .. | 3456 | 72.82 |
| P ₂ O ₅ .. | 142 | 2.99 |
| C ₆ O .. | 734 | 15.47 |
| 23H ₂ O .. | 414 | 8.72 |
| | 4746 | 100.00 |

Under the microscope this salt is seen to consist of fine yellow felted needles. It is very slightly soluble in cold water, but is soluble in rather large quantity of boiling water, giving an orange-yellow solution, with a strongly acid reaction. The solution gives with argentic nitrate a very insoluble sulphur-yellow floccy precipitate, which after a time becomes crystalline, and a pale yellow floccy precipitate with mercurous nitrate. No precipitate is formed with cupric sulphate or baric chloride. The salt could not be re-crystallised: it is interesting as a particularly well-defined soluble acid salt of the 24 : 1 atom series.

24 : 2 Acid Potassium Salt.—This salt was prepared by boiling together solutions of potassic molybdate and phosphate, adding an excess of nitric acid, and boiling the whole for some time. As in the case of the ammonium salts, the precipitation is greatly facilitated by this process taking place very slowly in the cold. The salt obtained was in very minute crystals, bright yellow, and but slightly soluble in cold water. Of this salt—

0.7772 grm. lost on ignition 0.128 grm. = 1.64 per cent water.

0.7962 grm. lost on ignition 0.0130 grm. = 1.66 per cent water.

0.1703 grm. gave 1.0895 grm. $\text{MoO}_3 + \text{P}_2\text{O}_5 = 93.10$ per cent.

1.3263 grm. gave 0.0779 grm. $\text{P}_2\text{O}_5 \cdot \text{Mg}_2 = 3.76$ per cent

1.3033 grm. gave 0.0778 grm. $\text{P}_2\text{O}_5 \cdot \text{Mg}_2 = 3.82$ per cent

The phosphoric oxide was twice precipitated as ammonio-magnesium phosphate. The analyses correspond with the formula—



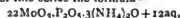
which requires—

| | Calc. | |
|----------------------------------|-------|--------|
| 24MoO ₃ .. | 3456 | 89.55 |
| P ₂ O ₅ .. | 142 | 3.69 |
| 2K ₂ O .. | 189 | 4.90 |
| 4H ₂ O .. | 72 | 1.86 |
| | 3859 | 100.00 |

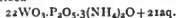
Twenty-two Atom Series.—In the paper already referred to, Rammelsberg has described several salts in which he found the ratio of molybdic to phosphoric oxide as 22 : 1. Unfortunately, he has not given the method of analysis which he employed, and in a question of so much difficulty and delicacy it is, to say the least, extremely desirable to know what degree of precision may be expected in the analyses. As his results appear to be supported by my

own, I shall adopt them, leaving to the further progress of analytical chemistry the final settlement of the few doubtful points.

22 : 3 Ammonium Salt.—Rammelsberg found for the neutral salt of this series the formula—



which corresponds, except as regards the amount of water of crystallisation, with a phospho-tungstate which I have already described—



In one preparation of a yellow insoluble ammonium salt exactly resembling the corresponding salt of the 24-atom series—

1.6885 grm. lost on ignition with WO_3Na_2 0.0873 grm. = 5.17 per cent NH_3 and H_2O .

1.7764 grm. gave 0.6200 grm. $\text{P}_2\text{O}_5 \cdot \text{Mg}_2 = 4.17$ per cent

1.9024 grm. gave 0.6029 grm. $\text{P}_2\text{O}_5 \cdot \text{Mg}_2 = 4.01$ per cent

1.2334 grm. gave 0.6262 grm. $\text{NH}_4\text{Cl} = 4.23$ per cent

The salt was dried for some time *in pleno* over sulphuric acid, and had evidently lost water of crystallisation. If we deduct the remaining water, 0.94 per cent, and calculate the analysis for an anhydrous salt, we have for the formula—



| | Calc. | |
|---------------------------------------|-------|--------|
| 24MoO ₃ .. | 3168 | 91.41 |
| P ₂ O ₅ .. | 142 | 4.09 |
| 3(NH ₄) ₂ O .. | 156 | 4.50 |
| | 3466 | 100.00 |

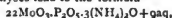
In another preparation—

1.0324 grm. lost on ignition with WO_3Na_2 0.0922 grm. = 8.93 per cent NH_3 and H_2O .

2.0670 grms. gave 0.1255 grm. $\text{P}_2\text{O}_5 \cdot \text{Mg}_2 = 3.88$ per cent

2.0352 grms. gave 0.1226 grm. $\text{P}_2\text{O}_5 \cdot \text{Mg}_2 = 3.84$ per cent

These analyses lead to the formula—



which requires—

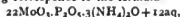
| | Calc. | |
|---------------------------------------|-------|--------|
| 22MoO ₃ .. | 3168 | 87.32 |
| P ₂ O ₅ .. | 142 | 3.91 |
| 3(NH ₄) ₂ O .. | 156 | 4.29 |
| 9H ₂ O .. | 162 | 4.48 |
| | 3528 | 100.00 |

If, from the analyses of the two salts above described we calculate the composition of the combination of molybdic and phosphoric oxides supposed to be isolated, and compare this with the percentages calculated upon the two hypotheses of a ratio of 22 : 1 and a ratio of 24 : 1, we have—

| | Calc. | I. | II. | Calc. | |
|-------------------------------|-------|--------|--------|--------|-----------------------------------|
| 22MoO ₃ | 3168 | 95.76 | 95.76 | 96.06 | 3456 24MoO ₃ |
| P ₂ O ₅ | 142 | 4.24 | 4.24 | 3.94 | 142 P ₂ O ₅ |
| | 3310 | 100.00 | 100.00 | 100.00 | 3598 |

In both cases the phosphoric acid was precipitated twice, but the ammonio-magnesium phosphate was not treated with ammoniac sulphide. According to the results of Dr. Gooch, already cited, the probable error of this method does not exceed 1 per cent in excess of the quantity of phosphoric oxide present. It appears, therefore, that the correction to be applied to the phosphoric oxide in the above analyses does not at most exceed 0.04 per cent. The mean of Dr. Gooch's analyses would require a deduction of 0.03

per cent only. The yellow ammonium salt analysed by Rammelsberg corresponds to the formula—



which requires (Rammelsberg)—

| | | Calc. | |
|---------------------------------------|------|--------|-------|
| 22MoO ₃ .. | 3168 | 86'04 | 86'45 |
| P ₂ O ₅ .. | 142 | 3'86 | 3'90 |
| 3(NH ₄) ₂ O .. | 156 | 4'24 | 3'25 |
| 12H ₂ O .. | 216 | 5'86 | 5'77 |
| | 3682 | 100'00 | 99'37 |

Rammelsberg gives these figures as the means of several analyses which agree well with each other, but it must be admitted that a closer correspondence with the percentages required by the formulae would have been desirable. The comparison is not given in his paper. The air-dried salt loses all its water over sulphuric acid. The three atoms of basic water, if we assume their existence, must therefore be united by a very feeble affinity. Rammelsberg has also analysed the corresponding potassic salt of the same series. I here give his results for the sake of comparison with the formula:—

| | | Calc. | |
|----------------------------------|------|--------|--------|
| 22MoO ₃ .. | 3168 | 83'17 | 84'43 |
| P ₂ O ₅ .. | 142 | 3'73 | 3'78 |
| 3K ₂ O .. | 283 | 7'43 | 6'86 |
| 12H ₂ O .. | 216 | 5'67 | 5'55 |
| | 3839 | 100'00 | 100'62 |

This salt loses all its water between 120° and 140°. In judging the results of these analyses, as well as of those which I have given, it must be carefully borne in mind that the salts themselves cannot be re-crystallised, and that consequently their absolute purity cannot be guaranteed. Moreover, if—as I believe I have shown—there are very similar salts which represent three series in which the ratios of the molybdic and phosphoric oxides are respectively as 24 : 1, 22 : 1, and 20 : 1, we may, at least occasionally, have mixtures of the salts of three or of any two series. The difficulty here is precisely that which occurs in the case of the phospho-tungstates.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, January 28th, 1882.

Dr. STONE, F.R.S. in the Chair.

NEW Member, Mr. W. Lant Carpenter.

Mr. T. WRIGHTSON read a paper by himself and Prof. W. CHANDLER ROBERTS, F.R.S., "On the Fluid Density of Metals." The results were obtained by the process described in a former paper to the Society on the fluid density of bismuth. The mean results were—For copper, 8'217; lead, 10'37; tin, 7'025; zinc, 6'48; silver, 9'51; iron (No. 4 Foundry Cleveland), 6'88. These results are slightly less than those given by Mallet's process, but they are sufficiently close. For bismuth the fluid density found by the authors is 10'05, which is slightly more than that given by Mallet's method (9'82). The authors consider their method satisfactory. It consists in suspending a ball of the solid metal from a spiral spring, and allowing it to dip into a crucible of the same metal in a molten state. The movements of the spring as the ball melts are recorded by a pencil on a band of travelling paper.

Mr. C. VERNON BOYS read a paper "On Apparatus for Calculating Efficiency." The object of such machines is

to automatically divide and continuously record the quotient of the speeds with which two things are turning. If the two things are the records of two of Boys's integrating machines (previously described to the Society), one finding work put into, and the other work sent out from, any combination of mechanism, then the quotient gives the efficiency of the combination. If one measures work or current and the other time or turns of a machine, the quotient measures the value of horse-power per hour or current per turn. Mr. Boys described four machines of the kind acting on two principles, from which he names them Logarithmic and Harmonic Dividers. They all derive their actions from motions of pure rolling. The simplest is made by hanging a magnetised steel reel on to a pair of iron cones which are turned by integrators. The reel travels about, and continuously shows the value of the quotient.

Mr. Boys then read a paper "On a New Current Meter." The rate of a pendulum clock depends on gravity, and is proportional to the square root of the strength of gravity. That of a watch depends on the strength of the hairspring, and is proportional to the square root of its strength. The force due to an electric current is proportional to the square of the current strength. Hence if part of an electric circuit is capable of vibrating under electromagnetic force, the speed of vibration will be proportional simply to the current strength, for the square of the speed measures the force, and the force is proportional to the square of the current. If, then, such a contrivance takes the place of the balance of a pendulum clock, the clock will measure electric currents instead of time. To keep the indications true the maintaining power must be so contrived that the amplitude does not vary much, or the parts must be so arranged that the force is directly proportional to the displacement. Mr. Boys showed several ways of producing a controlling power. The first was a combination of solenoids, one passing through the other, and in which the force was proportional to the displacement. Being without iron it applies to the case of alternating currents. In another a small armature is mounted on the balance staff, and around it are the two poles of an electromagnet which forms part of the circuit. In a third form, which is unaffected by residual magnetism, two crescent-shaped pieces of iron, forming the sides of the balance, pass through two fixed solenoids. In all these cases the direction of the current does not matter.

The maintaining power may be an ordinary escapement driven in the usual way. It may also be independent of clockwork, an impulse being given to the balance electrically at each swing. A meter of this kind was shown, in which the controlling power depends on iron crescents and solenoids, and in which a portion of the main current is shunted through secondary solenoids when the balance is in its neutral position, at which time a variation in the currents in the controlling solenoids has no effect in disturbing the period of oscillation. Such a meter is regulated by an adjustable weight if it goes too fast or slow. Being independent of gravity it will work equally well anywhere.

Prof. JOHN PERRY thought Mr. Boys's devices very promising, and mentioned that Professor Ayrton and he had invented a very simple current meter not yet described.

Dr. COFFIN pointed out that electric clocks of a certain class were really current meters.

Prof. GUTHRIE remarked that in Mr. Boys's meter practically no work was taken from the current.

Reference was made by Dr. Stone and Mr. Lecky to Hippas's clocks, the latter testifying to their efficiency.

Captain ABNEY, R.E., then exhibited some experiments on the Phenomenon of Phosphorescence. Balmain's luminous paint, calcium sulphide, and other substances give out a violet light after having been excited by daylight. Captain Abney found that when the spectrum was allowed to fall on an excited surface of Balmain's paint the blue rays enhanced this violet light and the red end of the spectrum extinguished it. This was shown to the

meeting, and the red end of the spectrum appeared on the paint in well-defined black bands. Similarly, the light from an electric lamp passed through a sheet of red glass extinguished the phosphorescence. Captain Abney's researches further show that there is a series of octaves in the blue end of the spectrum which refuse to quench the violet light. He found the mean wave-length of the rays exciting the phosphorescence to be 4300.

Prof. Guthrie also showed that calcium sulphide tubes glow in violet light.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

January 9, 1882.

MR. ROBERT R. TATLOCK, President, in the Chair.

THE minutes of the last meeting were read and confirmed.

MR. MACTEAR read a short paper on "*Fossilisation of Wood*." He pointed out how easily wood, subjected to the action of water containing lime and silica and then to that containing acid, might be fossilised, and showed some specimens of "bog wood" which he had partially fossilised by that means.

MR. WHITELAW having taken the chair,

MR. TATLOCK read a "*Note on the Valuation of Crude Saltpetre*."

The object of this note is to point out the fallacious character of the analyses of crude saltpetre made by what is known as the "refraction" method, which, unfortunately, is still employed by some chemists. According to this process all the chloride of potassium present is rendered, but of course erroneously so, as chloride of sodium, and as the amount of saltpetre is arrived at by difference, it must necessarily be in error to the extent of the difference between the combining weights of potassium and sodium calculated upon the proportion of potassium actually present in the form of chloride, and which is sometimes sufficiently large to affect very materially the value of the article as represented by the so-called "refraction." It will be apparent from this that in all cases a potassium determination is necessary, as otherwise the chemist is not in a position to state the true proportion of pure nitrate of potash in the sample examined; and unless this is done he is not, in my opinion, entitled to certify to the presence of a given amount, or to state the "refraction," which is obviously the same thing.

The following example of an "analysis" of saltpetre, as compared with a "refraction," will sufficiently serve to illustrate this:—

| | "Analysis" per cent. | "Refraction" per cent. |
|-----------------------------|-------------------------|---------------------------|
| Nitrate of potash | 76.33 | 78.91 |
| Sulphate of potash | 0.96 | 0.96 |
| Chloride of potassium | 11.96 | — |
| Chloride of sodium | 6.65 | 16.03 |
| Sulphate of lime | 0.26 | 0.26 |
| Chloride of magnesium .. | 0.27 | 0.27 |
| Insoluble | 0.27 | 0.27 |
| Water | 3.30 | 3.30 |
| | 100.00 | 100.00 |
| Refraction | 23.67 (Real.) | 21.09 (Apparent.) |

There is thus, in this sample, an obvious error of 2.58 per cent by the refraction method, in favour of the saltpetre; and as it sometimes happens that nitrate of soda is present in considerable quantity, a further error in the same direction may occur if a potassium determination is not made, and the nitrate of potash taken merely by difference.

MR. TATLOCK also gave a "*Note on Fireproofing of Cotton and other Fabrics*."

A vote of thanks was proposed both to Mr. Maclear and Mr. Tatlock.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, December 24, 1881.

MR. J. W. SWAN, President, in the chair.

THE PRESIDENT.—Before commencing the business of the meeting, I must mention a fact which it gives me great pain to have to communicate, I mean the death of Mr. Robert Calvert Clapham, the news of which has only just reached us. I am sure that only one feeling will exist amongst you, one of deep regret at the loss which we have sustained. I think it will probably be agreeable to your feelings that some official notice should be taken of this sad event. I will, therefore, move that a resolution in reference to it be drawn up and entered on our minutes, and that, after a decent lapse of time, it be communicated to his widow.

MR. SCHOLEFIELD.—I beg to second that motion, and, as the news has come so recently and unexpectedly, I think the wording of the resolution might be left to the President and Secretaries.

MR. JOHN PATTINSON.—I cannot help expressing my regret at hearing of Mr. Clapham's death. It is perhaps not known to all the members present that Mr. Clapham took a very active part in the formation of this Society, and has perhaps more right than anyone else to be considered as its founder.

The motion was carried unanimously.

MR. SWAN read the following paper on "*Voltaic Accumulation*." We owe the term voltaic accumulation to M. Planté; we owe the idea of voltaic accumulation to him also. But more than this, we owe to Planté the rich results of a life devoted almost entirely to researches in connection with this subject. M. Planté employs the phrase voltaic accumulation in a double sense—to signify storage, and to signify cumulative effect. It is in this last sense that the term is generally used by M. Planté, and it is to voltaic accumulation in this sense that M. Planté has chiefly directed his attention. One of his principal aims has been to produce by means of voltaic accumulation the high tension effects usually obtained from the frictional electrical machine. At no very distant period the phenomena of voltaic electricity and of frictional electricity were so widely different that a strong effort of the imagination and a clear perception of the laws governing these phenomena was necessary, in order to be able to entertain the belief that the agency which, led by naked wires, operated so quietly in causing the deposition of copper in large quantity from copper solution, could be the same which, bursting all bounds, rushed with flash and detonation to its goal.

When the platinum terminals of a voltaic battery composed of a few cells are made to dip in acid water, gas in torrents pours upward from them. If the same platinum poles, dipping in the same acid solution, be disconnected from the quietly but powerfully working battery, and put in connection with the prime conductor and the cushion of a large electrical machine of the frictional type, you may turn the handle by the hour and produce an amount of electricity that would maintain a continuous stream of fire, and yet not a single bubble of gas will rise from the platinum poles. Moreover, the voltaic cells which decomposed the water so rapidly would give no shock, nor the tiniest spark through the smallest measurable space of air; while the chemically inert-divide electrical machine would rack your limbs terribly and dart its spark through several inches of hair.

At a very early period of the history of the voltaic battery it was known that by largely multiplying the

series of cells, both sparks and shocks could be obtained from the terminal conductors; and on the other hand it was found that, by employing electrical machines of great power and forming poles of fine platinum wire coated with glass to the end, so as to reduce to almost a point the exposed surface of the platinum, water could be slowly decomposed.

In later years the two classes of phenomena characteristic of the voltaic battery and the electrical machine have made considerable advances towards each other. De la Rue has constructed a battery of 30,000 of his zinc and silver couple capable of producing a discharge through one-third of an inch of air; capable also of illuminating long vacuum tubes and of producing other effects of high electric tension. At the Paris electrical exhibition I saw an electrical machine on the Holtz principle, composed of 30 glass plates of small diameter, which was capable of decomposing water freely and of maintaining a thin platinum wire white hot as long as the plates were kept revolving. These approaches to identify of effect, by the electricity of voltaic action, of friction, and of induction, are of recent date. Before these results had been obtained, M. Planté, by means of methods the most ingenious and experiments the most striking, completely bridged the gulf that separates the phenomena of high tension and low tension electricity. M. Planté has achieved this result by means of secondary voltaic action.

The charging and re-charging of a series of 30,000 cells must evidently be an extremely troublesome operation. M. Planté avoids this trouble by making a few cells (two are sufficient) do the work of charging any number of secondary cells, which, after being charged, are joined in series, and made to develop high tension effects. This is chiefly the kind of accumulation performed by M. Planté by means of his secondary cell, namely, the accumulation of tension or electro-motive force. Here is a Planté cell. It consists of two plates of lead rolled together but separated by narrow strips of gutta-percha. These two lead plates being, to begin with, in the same condition, generate no current when immersed in dilute acid and united through the wire of a galvanometer. But if the couple be for a time connected, the one plate with the anode and the other with the cathode of a voltaic cell or any other form of electrical generator capable of developing an electro-motive force of not less than 3 volts, the anode plate becomes coated with peroxide of lead. If then the secondary cell be detached from the primary cells it will be found to be capable of generating a powerful current of about one-fifth more electro-motive force than Grove's cell. When it is desired to obtain cumulative effects from a series of Planté's cells, a mechanical arrangement is made whereby the plates of the different cells are so connected together that they are in effect one couple; that is to say, all the inner plates are connected together as one plate, and all the outer plates are connected together as one plate. Arranged in this manner, if one of the poles of two Grove cells coupled in series be connected with the terminal which is common to all the inner plates, and the other pole be connected to the terminal common to all the outer plates, the same change takes place in the too or it may be the 3000 cells as that which takes place in charging a single cell. That is to say:—if all the outer plates were connected with the positive pole of the Grove's cell, all these plates would be oxidised, and in this condition all the cells may be said to be charged just as a Grove cell is charged when one puts the nitric acid into it; for the highly oxidised lead of a Planté cell plays exactly the same part as the nitric acid of a Grove cell, and it is only necessary to alter the connection of one cell with another, so as to connect them in series, in order to obtain from them the cumulative electro-motive effect due to their number.

Planté has devised a convenient method of making this change in the connections. This apparatus illustrates the arrangement.

The cells are arranged in line with a spring projecting

upwards from each plate on each side of the line; between these two lines of springs an axle of ebonite runs, with metal bands so inlaid upon it, that when it is in one position all the springs on one side are pressing against a long strip of copper on that side, and all the other springs on a corresponding long strip of copper on the other side. In this position the cells are arranged for charging, the two long strips of copper being the two poles. When charging has been effected it suffices to turn the ebonite bar on its axis through a quarter of a circle in order to disconnect the springs from the two long strips of metal mentioned, and to bring them into contact with short strips of copper inlaid and insulated in the bar and crossing it obliquely so as to put the oxidised or positive plate of one cell in metallic communication with the non-oxidised plate of the next cell throughout the entire series. The change of connections is the work of a moment and the result is a multiplication of the electro-motive force by the number of the cells.

I saw at M. Planté's house, which is also his laboratory, 800 cells arranged in this way, all charged from two Bunsen cells, which were placed outside the room on the window sill. By means of this these 800 cells, worked in this convenient manner without the slightest annoyance from fumes or acids, the effects of about 900 Grove cells were obtained.

[Mr. Swan here illustrated the working of the apparatus by means of a battery of 20 small Faure cells arranged in a Planté commutating trough. When connected parallel, a copper wire was heated to whiteness and melted, and when in series, a Swan lamp was brilliantly illuminated.]

M. Planté went a step beyond this. He charged a large series of plates of mica, partly coated on each side with tin-foil, on the principle of the Leyden jar. These were connected in charging and in discharging in the same manner as the secondary battery, that is all the coatings of tin-foil turned one way were connected together, and all the coatings turned the other way were connected together. When, by the momentary joining of these two groups of plate coatings to the two poles of 800 secondary cells, the plates became charged, the connections were then changed from quantity to tension. By this contrivance the electro-motive force of the 4 volts, due to the two primary Grove cells, was accumulated first to 2800 volts and this again was increased fifty-fold by the mica plates. I can bear witness to the fact that it was sufficient to produce flashing discharges some inches in length, exactly resembling the discharges of a frictional electrical machine.

That is electrical accumulation in one sense, but there is another sense in which the phrase has been much used of late in connection with Faure's accumulator, namely, in the sense of storage. Planté's cell, with slight modifications, lends itself most perfectly to voltaic accumulation in the sense of storage. The very essence of the idea of storage is retentivity. The cell, to act as a reservoir or store, must be retentive of the charge communicated to it. This is a quality possessed in an eminent degree by the Planté cell. There is, comparatively with other voltaic cells which, but for the want of retentivity, might be employed for electrical storage, very little loss of charge by lapse of time with in the limit of a few hours. But for the defect of loss of charge by local action—that is, chemical action not utilisable in the production of electric current, the zinc and copper cell of Daniell and several other well-known voltaic combinations not usually regarded as susceptible of being used as secondary cells might have been employed for electrical storage.

Perhaps the ideal of a cell for storage is Grove's gas cell. Here is a specimen of it; it consists of two gas tubes, and two plates of platinised platinum immersed in dilute sulphuric acid. If, while the tubes are filled with dilute acid, one plate is connected with the positive and the other with the negative pole of a voltaic battery, the one tube becomes filled with oxygen and the other with hydrogen, and when so filled the cell is an electric store

capable, even after the lapse of a long time, of yielding a current.

But Grove's cell is quite out of the question for large operations, if only because platinum is so scarce. Theoretically it would perhaps be improved by making the hydrogen pole of palladium instead of platinum, so as to obtain the advantage of greater condensation of the hydrogen and thus to reduce the resistance by increasing the extent of the contact between the gases, the pole-plates, and the acidified water. Dr. C. W. Siemens communicated to the York Meeting of the British Association some interesting experiments in the employment of plates of carbon, both simple and platinised, as substitutes for platinum plates in the construction of a gas battery. The porosity of the carbon plates was utilised so as to bring the poles close together and greatly reduce resistance. The results obtained were well worthy of publication, although they did not quite reach the point aimed at, namely, practical utility for the electrical storage of energy.

I had imagined that De la Rue's cell, composed of zinc and silver incrustated with chloride of silver, might probably be employed in certain exceptional cases for electrical storage. On mentioning this very obvious idea to Dr. De la Rue, he told me there was a difficulty in the way, arising out of the tendency to the formation of oxychloride instead of chloride of silver.

For electrical storage on any large scale we look in vain to discover a better material than that fixed upon after infinite painstaking by M. Planté. Planté's cell, pure and simple, is a most admirable electrical accumulator in the storage sense of the word. It has one drawback, however, it requires a considerable time to give to the lead plates a large storage capacity. M. Planté's method of preparing his cell is as follows:—

"The secondary cell is first filled with water acidulated with sulphuric acid (1 quart acid to 10 quarts of water), and on the first day it is charged by the current from two Bunsen cells six or eight times, the direction of the primary current being changed at each new charge. The secondary cell is discharged between each reversal of the direction, and it is ascertained either by heating a piece of platinum wire to incandescence, or by other suitable means, that the duration of the secondary current continually increases after each charge.

"The time during which the secondary couple is submitted to the action of the primary current in the same direction is increased little by little.

"Thus, on the first day, the period is increased from a quarter of an hour to half an hour and one hour, and, finally, the battery is left over-night in the process of charging. The next day it is discharged and then recharged for two hours in the opposite direction, then again in the previous one, and so on. But soon a limit is reached, beyond which the duration of the secondary current is not found sensibly to increase, especially when the primary cells, not having been removed, have grown by these successive actions little by little weaker, and have no longer sufficient intensity to cause the electrolysis to penetrate deeper into the interior of the lead plates.

"The secondary couple is then left at rest for eight days, and at the end of that time is re-charged in the opposite direction for several hours continuously, without making on that day a fresh alteration in the direction of the primary current.

"Then the interval of rest is extended little by little to a fortnight, one month, two months, &c., and the duration of the discharge is found to go on continually increasing. It has, in fact, no other limit than the thickness of the lead plates. The positive plate, if it is thin, finishes by being almost entirely transformed by time into peroxide of lead of a crystalline texture; and the negative plate becomes formed by degrees, to a certain depth below its surface, of reduced lead of a granular and crystalline nature.

"It is not always necessary to push the electro-chemical

preparations of secondary couples as far as this complete transformation of the physical and chemical nature of the plates, for the couples would ultimately acquire a much greater resistance and take more time to charge them.

"When the couples yield a current of sufficient duration for the purposes for which one wants them, it is no longer necessary to change the direction of the primary current each time the cells are charged. The quantity of peroxide of lead accumulated upon the positive plate would take too long to reduce, and no result would be got from the couple before several hours. A definite direction is therefore adopted, in which the secondary cells, when once sufficiently 'formed,' are always charged."

It is evidently desirable—more especially in view of the want more and more urgently felt as time goes on, of an accumulator which will be available for the large and important uses to which electricity will in future time be put—if possible, to avoid this tedious process of preparation so minutely described by M. Planté. No doubt it answers the purpose quite well when industrial applications are not in the question, but for electrical accumulators such as must be used in connection with a central system of electric lighting, and which would probably involve the use of a set of large cells in every house, this slow process of preparation would be hardly applicable. It was with a desire to avoid this disadvantage and give to Planté's cells a greater capacity of storage, that I made the experiments last winter, the outcome of which was the modification of Planté's cell, which I showed you at our February meeting. Here are some of the cells I then exhibited in action. The idea of this modification was to increase the surface of the lead by means of lead foil, crimped and formed into frills, the interstices between the frillings being filled with electrolytically deposited spongy lead. The same idea has been applied in a somewhat different way by M. Faure in his accumulator. In M. Faure's accumulator red-lead, mixed with dilute sulphuric acid, is plastered on lead plates; the coated plates are wrapped in felt and either rolled up like the plates of a Planté's cell or doubled together, and placed in rectangular lead-lined wooden boxes. These cells have been made on a large scale, and for this reason, and because the application of the red-lead coating greatly favours the obtaining of storage capacity, effects have been obtained from them clearly pointing to practical use in electric lighting, and perhaps also for other purposes. The cell has, of course, the same electromotive force as the Planté cell, of which it is a modification; being large, it has, when fully charged, a small resistance, and is, on that account, capable of producing astonishing effects in the way of heating thick wire. [Heats some wire.] 30 of these cells, weighing about 50 lbs. each, when properly charged will keep 20 of my lamps up to 20 candle-power for several hours.

M. de Meritiens has also made an accumulator on the Planté lines. The Meritiens accumulator consists simply of plates built up of lead-foil. Here is a representation of one of his plates shown in section. I have not any accurate information of the working of De Meritiens's cell.

I have recently introduced into the construction of the Planté cell some modifications which, I anticipate, will increase its utility when applied on a large scale for the practical work of storage for electric lighting. One of my innovations consists in making the lead plates corrugated or cellular, the cells or grooves being filled with spongy lead, which from the form of the plate will remain attached to it without any external wrapping of felt or similar material being necessary. The felt in the Faure cell must, I imagine, be in a short space of time destroyed by the action of the acid, and occasion displacement of the material applied to the surface of the plate and held in its position by it. I have heard that it is proposed to substitute asbestos cloth for the felt—this no doubt will remedy the defect I have mentioned, but it must greatly increase the cost of constructing the cell. It is obviously

desirable to avoid the use of any extraneous material, and the use of grooves or cellular plates accomplishes this object. I have made other improvements for the means of obtaining electrical storage; details of which I must, for the present, hold in reserve, but with the hope at some future time of bringing them under the notice of the Society.

A hearty vote of thanks to Mr. Swan for his interesting paper and illustrations concluded the proceedings.

NOTICES OF BOOKS.

The Retrospect of Medicine. Edited by W. BRAITHWAITE, M.D., and JAMES BRAITHWAITE, M.D. Vol. lxxxiv., July to December, 1881. London: Simpkin, Marshall, and Co.

In this volume several articles relate to the germ theory of disease and the pathological action of microbia in the animal economy. Dr. Harley's important researches on the effects of animal and vegetable ferments introduced into the system are a step towards the solution of certain weighty questions. But they could never have been undertaken without certain operations which in these days are shrieked at as "vivisection." We do not find that the author, though he experimented with the venoms of the cobra and the puff-adder, comes to any conclusion as to the nature of these agents. In classifying the germs which produce human diseases, he draws a distinction between Brownian granules and micrococci, vibrios, and bacteria. He states that in each of three diseases—glanders, syphilis, and rabies—an entirely distinct organism is developed in the saliva. The thrush in the mouths of children, the potato blight, and the vine disease, as well as the epidemics among salmon and silkworms, are all, it is suggested, due to one kind of fungus, *Botrytis basiana*. Much additional light has been thrown on the "wool-sorters' disease." It is not confined to Bradford, but has proved fatal at Leicester, Norwich, Glasgow, Constantinople, and in Massachusetts, and it is suspected at the Cape, in Peru, and Asia Minor. It attacks packers, washers, carders, overlookers, and buyers, as well as sorters. Alpaca and mohair are not the only infective materials, as British wools—and, indeed, all hairs and wools except the Algerian—may contain uncleansed fleeces from animals which have died from anthrax. The danger to the workmen is found to be greatly lessened by washing the wools in warm water and sorting them whilst still damp. By this precaution the risk of inhaling the dust of moribund matter is greatly reduced.

Year-Book of Pharmacy: comprising Abstracts of Papers relating to Pharmacy, Materia Medica, and Chemistry, contributed to British and Foreign Journals from July 1, 1880, to June 30, 1881, with the Transactions of the British Pharmaceutical Conference at the Eighteenth Annual Meeting, held at York, August, 1881. London: J. and A. Churchill.

MUCH of the matter in this volume, extracted from the scientific journals at home and abroad, cannot of course lay claim to novelty. The ptomaine question is naturally treated at some length. The poison detected in sausages by Sonnenschein and Zuelzer, and the moribund matter shown to be present in decomposing maize and in certain samples of cheese, seem to belong here. The ptomaines are considered as including all alkaloidal products of decay, whether formed in the presence or the absence of air. The untrustworthiness of the ferricyanide test is insisted on, in quotations from A. Gautier and C. Tanret.

Fool's parsley (*Aethusa cynapium*), after being traditionally denounced as a poison, has been experimentally proved to be harmless. Mikania guaco is represented, on

the authority of Mr. R. B. White, of New Granada, as a cure for the bites of the most venomous snakes of South America. The use of saffron as a condiment, which still survives in Cornwall, is traced back to the Phenicians. It appears to us that the classification of the subjects as chemical or pharmaceutical is carried out more consistently in the present volume than was the case in former years.

Among the papers read before the Pharmaceutical Conference a prominent place belongs to that by Mr. C. Ekin, F.C.S., on the tests for nitrites in potable waters. He stated that the meta-phenylen-diamin test gives a distinct reaction with 1 part of nitrogen present in the form of nitrous acid in one million parts of water. The naphthylamin test detects with ease one part in one hundred millions, and with care even as little as one part in a thousand millions. The author shows, however, that the "old-fashioned potassium iodide and starch test" is, to say the least, equally delicate. If the solution is allowed to stand for some days (in a stoppered bottle) even smaller proportions than one part in a thousand millions are indicated. The author complains, as omissions, that the Rivers' Pollution Commission made no separate determination of nitrates as distinct from nitrites, whilst the Society of Public Analysts, in their recent circular on Water Analysis, omit the subject entirely. This is the more to be regretted, as the nitrites, if present in a water, are evidence of recent sewage in the very act of decomposition.

Catalogue of Dr. Schuchardt's Chemical Works, Görlitz.

DR. SCHUCHARDT stands, we believe, absolutely unrivalled in the specialty which he has taken up. At his establishment chemical preparations may be obtained, not merely of the highest possible purity, but in large, regular, and beautiful crystals. Hence they are admirably adapted for optical, crystallographic, and thermo-chemical researches, and for preservation in museums as characteristic specimens. The preparations are arranged according to their crystalline systems. A peculiarity of the catalogue is that the various bodies have received the Latin pharmaceutical names instead of those used in pure chemistry and in manufactures. Thus "Natrium chloratum" means not, as might be naturally supposed, sodium chloride, but sodium chloride. We do not see what is gained by this exceptional nomenclature, which but for the formulae accompanying would be perplexing. Dr. Schuchardt's beautiful collections of crystallised chemicals have been much admired at various exhibitions.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 1, January 2, 1882.

Diffusion of Solids.—A. Colson.—If discs of iron, already partially carburized, are heated along with fresh discs, both absorb the same quantity of carbon if the diffusion of carbon in the metal is proportional to the duration of the heating. To a given temperature there corresponds a constant coefficient of diffusion of carbon in the iron. This law is only true when the iron is converted into steel; when cast-iron begins to be formed, that is, a little before the iron becomes brittle, the absorption of carbon decreases. Silica ranks among the bodies most easily diffusible in carbon. By heating platinum in lamp-black containing 60 per cent of precipitated silica, we obtain a crystalline body, Si_2P_3 , of the specific gravity 14.1,

and melting at about the same temperature as common glass.

Diffusion of Carbon.—J. Violle.—The author refers to a fact which he observed and described in the *Comptes Rendus* (lxxxvii., p. 981), i.e., the diffusion of carbon in porcelain. This phenomenon may be observed if a porcelain crucible is placed within one of graphite and heated to 1000° to 1500°.

Determination of the Ohm: a Reply to M. Brillouin.—M. Lippmann.—The object being the determination of the ohm as exactly as possible, it is sufficient to reach it by the use of coils of ordinary dimensions. It appears superfluous to insist upon giving impracticable dimensions to these instruments in order to find the author's method defective.

Measurement of Potentials Corresponding to given Explosive Distances.—J. B. Baile.—The potential of an electrified plane increases about regularly with the explosive distance to be traversed. The electric densities may be calculated corresponding to these different spark-lengths; it will be seen that these densities decrease at first slowly, and soon arrive at a constant value, about 0.5 c.m. The pressure exerted by electricity upon the air at the moment when the spark is about to spring 0.01 metre is only 1.200th of the atmospheric pressure.

Proportion of Potassa to Soda in Natural Waters.—C. Cloëz.—Except in especial cases the potassa contained in waters is at the most one-fifth of the sum of the alkalies, and if it is derived from the decomposition of felspar rock, another origin must be sought for the soda. As the chlorine present is in the majority of cases proportional to the sodium, it follows that all soils, with the possible exception of the granitic, are impregnated with sea-salt, whilst the argillaceous soils alone contain potassium salts.

Complex Function of Morphine and its Transformation into Picric Acid: its Solubility.—M. Chastaing.—The author mentions certain reactions which confirm the phenolic function of morphine. Tetrahydrated nitric acid at 100° converts morphine into an acid, $C_{20}H_{19}NO_{18}$, which, if heated in a sealed tube to 200° with monohydrated nitric acid, is converted into picric acid. Hence morphine contains an aromatic nucleus. One litre of water at 0° dissolves traces of morphia; at 10°, 0.10 gm.; at 20°, 0.20 gm., &c., but above 45° the solubility of morphia increases more rapidly.

Artificial Production of the Forms of Organic Elements.—D. Monnier and C. Vogt.—Figured elements presenting all the characters of form belonging to the organic elements, such as cellulose, either simple or with porous canals, tubes with sides, with septa, and with heterogeneous granular contents, can be artificially produced in an appropriate liquid by the joint action of two salts, forming by double decomposition, either two insoluble salts, or a single one. One of the original salts must be present in solution, whilst the other is added in a solid form. [In February, 1878, M. G. Fournier, of Paris, performed experiments giving substantially similar results in presence of the Editor and a friend.]

Zeitschrift für Analytische Chemie.
Vol. xi., Part 3.

Spectroscopic Researches.—C. L. Ciamician.—Already noticed.

The Spectrum of Glucinum.—C. L. Ciamician.—This spectrum is perfectly homologous with those of carbon, boron, and magnesium.

Separation of Copper and Cadmium.—G. Vortmann.—The dilute solution (sulphuric or hydrochloric) of the metals is mixed with sodium hypophosphite till completely decolourised, and is then heated to a boil, when the copper is separated as a heavy black sulphide. The boil-

ing is continued till the liquid has become clear. After filtration and careful washing the copper sulphide is mixed in the known manner with sulphur, and heated in a current of hydrogen. The cadmium in the filtrate is precipitated by one of the known methods.

Detection of small Quantities of Morphia.—A. Jorissen.—The solution of morphia, free from foreign bodies, is evaporated to dryness, and the residue is heated on the water-bath with a few drops of sulphuric acid. A minute crystal of ferrous sulphate is then added, bruised with a glass rod, stirred up in the liquid, heated for a minute longer, and poured into a white porcelain capsule, containing 2 to 3 c.c. strong ammonia. The morphia solution sinks to the bottom, and where the liquids touch there is formed a red colour, passing into violet at the margin, whilst the ammoniacal stratum takes a pure blue. The reaction is very distinct to 0.0006 gm. Codeine does not give this reaction. If sulphuric acid at 190° to 200° is allowed to act upon morphia, there is ultimately formed an opaque black-green mass. If this is poured dropwise into much water, the mixture turns bluish, and if it is then shaken up with ether or chloroform, the former takes a purple and the latter a very permanent blue. Codeine gives the same reaction, but no other of the alkaloids. This reaction can be obtained very distinctly with 0.0004 gm. of morphia.

Journal de Pharmacie et de Chimie.
September, 1881.

Action of Arsenic and Phosphoric Acids upon the Sodium Tungstates, and a New Method for the Analysis of the Tungstates.—Jules Lefort.—For determining the tungstic acid of a soluble tungstate it is sufficient to acidify slightly with acetic acid, and to add quinine acetate or sulphate in slight excess dissolved in distilled water. There is produced an abundant white precipitate, which shrinks on standing, and is washed with cold water. The deposit is collected on a filter, dried in the stove, and is then heated to redness in a platinum crucible. By the successive addition of a few drops of nitric acid all the quinine is destroyed, and tungstic acid alone remains, and is weighed. This method is perfectly exact.

Anæsthetics.—Alfred Riche.—A medical paper.

Phytolacca Dioica.—M. Ballard.—The author has not succeeded in discovering the presence of an alkaloid.

Quinoidine Borate.—M. de Vrij.—The author examines the value of this compound as a febrifuge.

Poisonous Matters Produced by Man and the Higher Animals.—Armand Gautier.—The author has extracted from normal urine, from the poison of the cobra, and from human saliva, poisons closely resembling the *ptomaines*, forming crystalline chloraurates, and chloroplatinates, and having the power of rapidly reducing potassium ferricyanide.

Poisonous Action of Potassium Chlorate.—M. Ludwig.—Potassium chlorate is completely reduced in the human organism to potassium chloride. Its action is similar to that of arsenic and phosphorus.

October, 1881.

Anæsthetics.—A. Riche.—An illustrated paper continued from the September number.

Action of Arsenic and Phosphoric Acids upon the Sodium Tungstates, and a New Method of Analysing the Tungstates (Continued from the last number).—Jules Lefort.—The author distinguishes the yellow metatungstic acid from the colourless variety, and proposes to give it the name of meta-luteo-tungstic acid.

Formula of Pilocarpine.—P. Chastaing.—According to the author the formula of pilocarpine is $C_{22}H_{27}N_3O_4$. The formula of Mr. Kingzett would require 32.85 per cent of carbon.

Certain Oxidation-Products of Morphine.—P. Chastaign.—By the action of gaseous hydrochloric acid upon the alcoholic solution of morphine, the author has obtained a hydrated oxy-morphine. By the acid of nitric acid upon morphine he has obtained a series of acid products, the nature and relations of which require further study.

Determination of Tannic Acid.—M. Lehmann.—The author takes a quantity of the sample supposed to contain from 2 to 6 decigrammes of tannic acid. It is exhausted with boiling water, and the liquid is concentrated down to 100 or 200 c.c. of filtrate. To 20 c.c. of this solution are added 20 c.c. of a saturated solution of ammonium chloride. There is then run into the mixture by means of a burette graduated in tenths of c.c. a solution containing 1 gram. gelatin in 100 c.c. of a saturated solution of ammonium chloride. The presence of this salt renders the separation of the precipitate both rapid and very distinct. The flow of the solution of gelatin is stopped as soon as a precipitate no longer forms. To find the exact moment when the tannin is entirely precipitated a small quantity of the liquid is filtered, and the filtrate is tested upon a watch-glass with solution of gelatin and with the solution of the sample. It should give no precipitate with either. The gelatin solution is standardised previously with a solution of pure tannin.

Novel Reactions of Milk.—C. Arnold.—If a little tincture of guaiacum is added to fresh milk a blue colour is produced. Milk heated to 80° or upwards remains uncoloured. Sour milk takes the same tint, but the reaction is prevented by the addition of mineral acids and alkalis. If a little starch-paste mixed with potassium iodide is added to milk which has been mixed with old oil of turpentine, a fine blue band appears at the surface of contact and spreads rapidly. Milk freed from albuminous matter does not give this reaction. If to fresh milk there is added first acetic acid to precipitate the casein, then some caustic potassa, and lastly a trace of a solution of copper sulphate, the violet reaction characteristic of peptone does not appear, but if the milk is allowed to stand fifteen to twenty hours before this treatment, the violet colour is obtained. The author considers the blue colour due to ozone.

Die Chemische Industrie. Vol. 4, No. 10.

This issue is taken up with the report of the meeting of the German Association of Chemical Manufacturers, held Sept. 17th, at Reichenhall; an important report presented by Dr. G. Lunge to the Congress of German Alkali Manufacturers, Sept. 15th; and the list of chemical patents.

Vol. 4, No. 11.

This number contains the conclusion of Dr. Lunge's report to the Association of German Alkali Makers.

Vol. 4, No. 12.

Determination of Small Quantities of Arsenic in Sulphur.—H. Schœpfi.—10 grms. of sulphur, pulverised as finely as possible, are covered with hot water and a few drops of nitric acid, digested for some time, filtered, and washed till the washings have no longer an acid reaction. This calcium chloride and sulphate are removed, and calcium sulphide if present is destroyed. The sulphur thus prepared is covered with water at 70° to 80°, and a few drops of ammonia are added, and the mixture is digested for a quarter of an hour. All the arsenic present as sulphide is dissolved, and the ammoniacal liquid is variously treated according to the degree of accuracy required. For perfectly accurate determinations the ammoniacal solution is mixed with silver nitrate, and all the sulphur present in the state of arsenic sulphide is thrown down as silver sulphide, acidified with nitric acid, filtered, and washed. The precipitate of silver sulphide is dissolved in hot nitric acid and determined as silver chloride. From the weight

of the latter the arsenic sulphide is calculated. As a less accurate but more rapid method the ammoniacal solution of arsenic sulphide is cautiously neutralised with pure dilute nitric acid and considerably diluted. It is then titrated with decinormal silver nitrate till a drop of the solution is turned brown with neutral chromate. The arsenic is easily calculated from the quantity of silver nitrate consumed. For very rough determinations it is sufficient to treat 10 grms. of finely-ground sulphur with nitric acid, to extract with ammonia, and to add silver nitrate. From the intensity of the colour, or the quantity of the precipitate of silver sulphide, it may be judged if the sulphur is approximately free from arsenic or strongly contaminated. The author states that contrary to the general belief, reddish-yellow sulphur is more free from arsenic than such as is of a full yellow colour.

Bulletin de la Société Chimique de Paris. Tome 36, Nos. 8 and 9.

Certain Derivatives of the Dichlorinated Naphthalenes δ and ϵ .—J. E. Allen.—The author examines the oxidation of dichloro-naphthalenes δ and ϵ , as effected by nitric acid at different strengths.

Archives Néerlandaises des Sciences Exactes et Naturelles. Tome xvi., Livraison 4.

The Influence of the Moon on the Movement of the Magnetic Needle.—S. P. Van der Stok.—A mathematical discussion of observations.

Crystallisation of the Diamond.—H. Behrens.—The author rejects the supposition that the diamond is formed by successive layers.

MEETINGS FOR THE WEEK.

- MONDAY, 6th.—London Institution, 5.
— Medical, 8.30.
— Society of Arts, 8. "Recent Advances in Photography," by Capt. W. de W. Abney, F.R.S.
— Royal Institution, 5. General Monthly Meeting.
TUESDAY, 7th.—Institute of Civil Engineers, 8.
— Royal Institution, 3. "The Mechanism of the Senses," by Prof. J. G. McKendrick.
— Pathological, 8.30.
— Society of Arts, 8. "Notes on the Trade Capabilities of Newfoundland," by E. Hepple Hall.
WEDNESDAY, 8th.—Society of Arts, 8. "The Manufacture of Ordnance," by Colonel Maitland.
— Geological, 8.
— Microscopical, 8.
THURSDAY, 9th.—Royal, 4.30.
— London Institution, 7.
— Royal Institution, 3. "Corals," by Prof. H. N. Moseley.
FRIDAY, 10th.—Royal Institution, 8. "The Climate of Town and Country," by Professor Frankland, 9.
— Quekett Microscopical Club, 8.
— Astronomical, 8. (Anniversary.)
SATURDAY, 11th.—Royal Institution, 3. "Ludwig van Beethoven," by Prof. Pauer.
— Physical, 3. Annual General Meeting. "On the Relations between the Electromotive Force of a Daniell's Cell and the Chemical Affinities Involved in its Action," by Dr. C. R. Alder Wright.

NOTES AND QUERIES.

*. Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Combination of Acids and Bases.—I should be glad to hear where I could see an account of how the acids and bases are combined together in a compound. In making an analysis of a mineral water what bases and acids are generally put together in drawing up the report.—A.D.

TO CORRESPONDENTS.

J. K.—The subject is a purely medical one and not within our province.

THE CHEMICAL NEWS

VOL. XLV. No. 1159.

THE ANALYSIS OF POTABLE WATER, WITH SPECIAL REFERENCE TO THE DETERMINATION OF PREVIOUS SEWAGE CONTAMINATION.*

By CHARLES W. FOLKARD.

In the first place, the author reviewed the present state of analytical chemistry, the conclusion being that, as far as mineral substances were concerned, the existing methods were nearly perfect. But when organic analysis was considered, a different state of things was apparent, owing to the great number, complexity of structure, and unstable nature of many organic bodies, especially those contained in the sections and tissues of plants and animals; in addition to which organic matter was present in drinking water in very small quantities, and always more or less mixed with other substances.

The subject might be divided into four parts:—1. The various ways in which water became contaminated. 2. The methods employed by analysts to detect and determine the extent of this contamination, with an opinion as to the probable value of these methods. 3. The bearing of the results of biological and microscopic investigations on the subject. 4. The utility of irrigation, chemical treatment, and filtration, for purifying purposes.

Under the first of these heads, the normal constituents of rain-water were considered, all of which were practically harmless, so that rain-water as it fell on the earth, or on the gathering grounds of a system of water-supply for a town, was unobjectionable, having contracted but an inappreciable amount of contamination. Spring-water was not so pure, owing to its percolation through strata from which various mineral substances were dissolved. River-water was the most objectionable, on account of the enormous quantities of animal and vegetable contamination which it acquired. Lastly, well-water varied greatly in quality, in some cases being excellent where the wells were deep and surface water was excluded, or when the district was thinly peopled; in other instances well-water was more contaminated than river-water, as in shallow wells in towns.

Under the second heading, the author pointed out that analytical chemists had hitherto been compelled to be content with the examination of the products of decomposition, or with the determination of the products of decomposition elements of the organic impurities of water. Unfortunately the products of decomposition of the organic matter in water were the same as the normal constituents of rain, viz., carbonic acid, ammonia, and nitric acid. It was therefore impossible to ascertain whether those substances were derived from contaminating bodies or had been dissolved by the rain in falling.

The various processes of water analysis were then considered. In the first and oldest method a measured quantity of water was evaporated, and the residue was subjected to a red heat in a platinum dish. By this treatment the animal and vegetable substances were burnt away, and from the loss of weight the amount of organic matter was inferred. One great objection to this and the following process was the evaporation of the water. With such unstable bodies it was by no means improbable that a large portion was destroyed during the process.

By the second method the solid matter, left after

evaporation of a known quantity of the water, was mixed with an oxidising agent and heated to redness in a glass tube. The carbon and nitrogen of the organic matters in the residue were obtained in the form of carbonic acid and nitrogen gases, from which were deduced the weight of carbon and of nitrogen present as organic matter in the residue. This ratio of carbon to nitrogen did not, however, afford the slightest clue to the identity of the organic matter. It might be intensely poisonous or dangerous, or, on the other hand, harmless.

The albumenoid-ammonia method consisted in boiling the water with an alkaline oxidising agent, by which the organic matter was decomposed, and part of its nitrogen evolved in the form of ammonia. This had the great advantage of simplicity of manipulation, and was not open to the objection that previous evaporation was required.

The last considered was the permanganate method. In this the index of impurity was the amount of oxidising agent, namely, permanganate of potash, required to destroy the organic matter in the water. Inasmuch, however, as no relation had been established between the oxidizability of a body and its action on the animal economy, this method would not afford reliable evidence of the fitness of a sample of water for drinking purposes or the reverse.

Under these circumstances the conclusion seemed inevitable, that the subject was as yet beyond the power of the analytical chemist.

It was, however, possible, by the second method, to determine approximately the minimum amount of contamination which had taken place since the water was precipitated as rain. For this purpose the whole of the nitrogen existing in the water was estimated, and the average amount in rain falling on the surface of the earth deduced. The remainder was due to animal and vegetable contamination, and it had been found convenient to express it in parts of average London sewage; that was to say, the sample was returned, as having been contaminated to the same extent as if pure rain-water had been mixed with so many parts of ordinary sewage. But this afforded no direct evidence as to its fitness for dietetic purposes, because subsequent oxidation and fermentation might have rendered the water to a great extent harmless.

The author next considered the bearing of biological research on the subject, pointing out that mere dilution had an almost inappreciable effect in disarming the germs of disease of their power. Thus, supposing a glass of water to contain but one germ, if the person taking it was sufficiently unhealthy or weakly, he would contract the disease almost as certainly as if there were hundreds of germs. In the author's opinion it would be impossible to banish zymotic disease from towns, the water supply of which contained the debris of persons suffering from the disease, even though present in the most minute quantity. The very weakly would contract the complaint from the water, and from them it would spread to the more robust around them. Again, these germs were endowed with such consistent vitality, that they withstood the effects of heat and cold, moisture, drought, and chemical agents to an almost incredible extent, affording what seemed, at first sight, indisputable evidence of the now exploded doctrine of spontaneous generation. From this it appeared that once-contaminated water was unsuitable for dietetic purposes.

In conclusion, the author contended that a radical change was the only remedy. Irrigation and chemical treatment were alike powerless; in addition to which, during heavy rain all existing sewerage systems were incapable of dealing with the huge volumes of water poured into them, and the sewage was allowed to flow direct into the river, to the manifest disadvantage of the towns below, who were dependent upon it for their water supply. Filtration, again, was powerless to effect real purification. The germs of disease were so minute that they could pass one hundred abreast through the interstitial spaces of ordinary sand, and dissolved substances were of course

* A Paper read at the Ordinary Meeting of the Institution of Civil Engineers on Tuesday, the 24th of January, Mr. Brunlees, Vice-President, in the chair.

unaded upon. In view of the great increase in cancerous diseases of the stomach and intestines, the subject was worthy of the most careful study, and taking into consideration the unreliability of the results afforded by chemical analysis, the only way to ascertain if a sample of water was fit for drinking purposes was, in the author's opinion, to trace it to its source, and see that contaminating matter was excluded, from the time that the water fell as rain till it entered the reservoir or engine-well.

RESEARCHES ON THE COMPLEX INORGANIC ACIDS.*

By WOLCOTT GIBBS, M.D.,
Rumford Professor in Harvard University.

(Concluded from p. 52.)

PHOSPHO-MOLYBDATES.

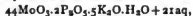
44:2 Acid Potassium Salt.—This salt was prepared by boiling a mixture of potassic molybdate and phosphate with nitric acid in excess, when a beautiful yellow crystalline powder separated. This was washed with cold water and dried on woolen paper. Of this salt—

0.9850 grm. lost on ignition 0.0521 grm. = 5.28 per cent water.

0.8983 grm. gave 0.7943 grm. $\text{MoO}_3 + \text{P}_2\text{O}_5 = 88.42$ per cent.

2.0617 grms. gave 0.1201 grm. $\text{P}_2\text{O}_7\text{Mg}_4 = 3.72$ per cent.

These analyses lead to the formula—



OF—

$22\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot 3\text{K}_2\text{O} + 22\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot 2\text{K}_2\text{O} \cdot \text{H}_2\text{O} + 21\text{aq.}$
which requires—

| | | Calc. | |
|------------------------------------|------|--------|--------------|
| 44 MoO ₃ .. | 6336 | 84.62 | 84.70 |
| 2 P ₂ O ₅ .. | 284 | 3.79 | 3.72 |
| 5 K ₂ O .. | 472 | 6.30 | 6.30 (diff.) |
| 22 H ₂ O .. | 396 | 5.29 | 5.28 |
| | 7488 | 100.00 | |

The salt is therefore the acid salt corresponding to a neutral salt with the formula—



Rammelsberg's analyses agree better with the formula of the acid salt given above than with that of the neutral compound assumed by him.

Twenty Atom Series.—The only salt of this series which I have obtained is one of ammonium prepared like the salts already described, having like these a fine yellow colour and a very fine-grained crystalline structure, and, like them, but slightly soluble in water. Of this salt—

1.0936 grm. lost on ignition with WO_3Na_2 0.0720 grm. = 6.66 per cent NH_3 and H_2O .

1.8183 grm. lost on ignition with WO_3Na_2 0.1155 grm. = 6.35 per cent NH_3 and H_2O .

0.8862 grm. gave 0.6153 grm. $\text{NH}_4\text{Cl} = 4.12$ per cent $(\text{NH}_4)_2\text{O}$.

1.3213 grm. gave 0.6224 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 4.19$ per cent P_2O_5 .

1.5135 grm. gave 0.6349 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 4.31$ per cent P_2O_5 .

The salt was dried on a water-bath, and afterward over sulphuric acid. The phosphoric oxide was precipitated twice, but not treated with ammoniac sulphide. The analyses led to the formula—



which requires—

| | | Calc. | |
|--|------|--------|-------|
| 60 MoO ₃ .. | 8640 | 89.09 | 89.21 |
| 3 P ₂ O ₅ .. | 426 | 4.39 | 4.31 |
| 8 (NH ₄) ₂ O .. | 416 | 4.29 | 4.12 |
| 12 H ₂ O .. | 216 | 2.23 | 2.54 |
| | 9998 | 100.00 | |

If we calculate the composition of the mixed oxides of molybdenum and phosphorus existing in this salt, we have—

| | | Calc. | |
|----------------------------------|------|--------|--------|
| 20 MoO ₃ .. | 2880 | 95.30 | 95.39 |
| P ₂ O ₅ .. | 144 | 4.70 | 4.61 |
| | 3024 | 100.00 | 100.00 |

It will be seen that the ratio is here very nearly as 20:1. This may, however, be merely accidental, and further researches are necessary to fully establish the existence of a 20-atom series.

According to Debray, a solution of argentic nitrate gives with one of phospho-molybdic acid a precipitate which soon becomes crystalline, and which has the formula—



Such a salt would possess a twofold interest, first, as another evidence of the existence of a 20-atom series of phospho-molybdates; and, secondly, as showing that the acid of the series may unite with more than six atoms of base. On mixing the two solutions as above, I obtained a precipitate in small indistinct crystals of a greenish yellow colour. These crystals were soluble in hot water, but the solution was quickly decomposed with precipitation of a white powder. Under the microscope, with a high power and transmitted light, the salt appeared to consist of small tabular crystals mixed with a few long yellow prisms of very different habitus. Of this compound—

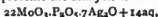
1.3604 grm. lost by ignition with WO_3Na_2 0.0622 grm. water = 5.08 per cent.

2.1099 grms. gave 0.8287 grm. $\text{AgCl} = 31.63$ per cent Ag_2O .

0.6733 grm. gave 0.2619 grm. $\text{AgCl} = 31.44$ per cent Ag_2O .

2.1099 grms. gave 0.0928 grm. $\text{P}_2\text{O}_7\text{Mg}_4 = 2.81$ per cent P_2O_5 .

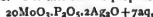
The phosphoric oxide was determined in the filtrate from the argentic chloride by double precipitation and treatment with ammoniac sulphide. The ratio of the molybdic to the phosphoric oxide is as 21:1, but the formula which most nearly represents the analysis is—



which requires—

| | | Calc. | |
|----------------------------------|------|--------|-------|
| 22 MoO ₃ .. | 3168 | 61.08 | 60.37 |
| P ₂ O ₅ .. | 142 | 2.74 | 2.81 |
| 7 Ag ₂ O .. | 1624 | 31.32 | 31.44 |
| 14 H ₂ O .. | 252 | 4.86 | 5.08 |
| | 5186 | 100.00 | |

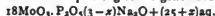
The only conclusion which can fairly be drawn from the analysis is that there is at least one phospho-molybdate in which the number of atoms of base exceeds three. It is certain that the salt does not represent a perfectly definite and homogeneous compound, and it may possibly be a mixture of the 20-atom salt, $20\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot 6\text{Ag}_2\text{O}$, and an acid molybdate of silver, $2\text{MoO}_3 \cdot \text{Ag}_2\text{O}$, nearly in atomic proportions. By dissolving the salt in nitric acid and evaporation, Debray obtained another salt in small brilliant yellow crystals. For this salt he proposes the formula—



but as usual he has given no analyses.

* Proceedings of the American Academy of Arts and Sciences, communicated by the Author.

Eighteen Atom Series.—I have myself met with no salts belonging to this series, but according to Finkener* there are sodium salts corresponding to the general formula—



These salts are yellow and easily soluble.

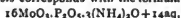
Sixteen Atom Series.—16:3 Ammonium Salt.—In preparing the 5:3 atom ammonium salt a white crystalline precipitate was formed, insoluble in cold, but soluble with decomposition in much boiling water, and easily soluble in ammonia. In this salt dried over sulphuric acid—

0.5100 grm. lost by ignition with WO_3Na_2 0.0722 grm.
= 14.16 per cent NH_3 and H_2O .

1.7653 grm. gave 0.1259 grm. NH_4Cl = 5.25 per cent $(\text{NH}_4)_2\text{O}$.

0.8114 grm. gave 0.0658 grm. $\text{P}_2\text{O}_5\text{Mg}_2$ = 5.19 per cent P_2O_5 .

The analysis corresponds with the formula—



which requires—

| | Calc. | Found. |
|---------------------------------------|-------|--------|
| 16MoO ₃ .. | 3304 | 80.73 |
| P ₂ O ₅ .. | 142 | 4.97 |
| 3(NH ₄) ₂ O .. | 156 | 5.46 |
| 14H ₂ O .. | 252 | 8.84 |
| | 2854 | 100.00 |

FURTHER NOTES ON ACTINIUM, AND ON THE EQUIVALENT OF ZINC.

By Dr. T. L. PHIPSON, F.C.S., &c.

SINCE my last communication on Actinium in this Journal, and my letter to the Editor stating that the new metal had been isolated from its ammonio-chloride solution by means of magnesium, I have had little opportunity of pursuing these researches. The difficulty which I at first experienced of entirely separating all traces of zinc oxide from actinium oxide, by means of caustic soda, still subsists; so that the blowpipe reaction of oxide of actinium with chloride of cobalt is uncertain. The result is a mass of a magnificent dark emerald-green, a much finer and darker colour than is seen with purified zinc oxide; but how much of this is due to one or the other metal it is impossible to say at present.

The purified zinc oxide obtained, during these experiments, in a crystalline state from the soda solutions, has served me for a new determination of the equivalent of zinc, and the results all point very distinctly to the equivalent 32, which is a multiple by a whole number of H, and so according to the law of Proust. The method employed consisted in dissolving this purified zinc oxide in HCl, precipitating with pure carbonate of soda, washing, calcining, and converting a given weight of the oxide thus obtained into sulphide. The details will be published later.

I have also obtained a sulphide of actinium (in an allotropic form ?) which is only slightly sensitive to the action of light, whereas the ordinary sulphide darkens very visibly in a few minutes, and is quite black, or slate-coloured, on being exposed for twenty minutes to the sun. This intense darkening cannot be due, as some may suppose, to the presence of silver, mercury, cadmium, arsenic, &c., because the original liquor was, in the first place, submitted to HS for twenty-four hours, and next, because with actinium compounds the action does not occur under a sheet of glass.

In the latter respect actinium is interesting as bringing out a new and curious property of glass. Hitherto the compounds used in photography have been so sensitive

that the action of light, even under glass, is more or less instantaneous, and no difference has been observed. But with the ordinary actinium sulphide it requires at least twenty minutes, in good morning sunshine, to produce the dark grey tint, and in such an interval the action under a piece of plate glass about 2 millimetres thick is absolutely nil.

Glass has, therefore, the property of arresting a certain amount of actinic rays, as other transparent substances are known to arrest rays of heat—a property which glass possesses.

The plate glass used in these observations is slightly green on its action; but very similar results are obtained with various other kinds of white glass, even when much thinner than that mentioned. A fact which is still more curious is, that a plate of dark blue glass, which is supposed to allow actinic rays to pass easily, protects the substance in question from the sun's action just as much as a plate of white glass does.

London, February 3, 1882

ON SOME SALTS OF CHROMIUM AND MERCURY.

By F. W. CLARKE and DAVID STEARN.

THE double salts which mercuric chloride and mercuric cyanide form with certain alkaline chromates have long been known. The following have been described:—

1. $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2 \cdot \text{H}_2\text{O}$ Darby, Richmond and Abel.
2. $3(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2$ Richmond and Abel.
3. $\text{K}_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2$ Millon. Darby.
4. $\text{K}_2\text{CrO}_4 \cdot 2\text{HgCl}_2$ Darby.
5. $\text{K}_2\text{CrO}_4 \cdot 2\text{HgCy}_2$ Poggiale. Calliot & Pödevin.
6. $\text{Ag}_2\text{Cr}_2\text{O}_7 \cdot 2\text{HgCy}_2$ Darby.

These salts we have subjected to a re-examination, and we have sought to prepare others of the same series.

The first of the foregoing compounds was our chief object of study. Our results concerning the others may be stated briefly. Salts numbered 3 and 4 we prepared, but found them difficult to purify. To number 5, Darby and Rammelsberg both assign the formula—



This formula requires 9.09 per cent of chromium, while the one given above corresponds to 7.45 per cent. We found 7.62 per cent, thus confirming the simpler formula. The salt numbered 6 we found easy to prepare, and we verified its composition. We tried also to obtain a corresponding salt containing thallium in place of silver, but only thallium dichromate was deposited. We also attempted to produce double salts of mercuric cyanide with ammonium chromate, ammonium dichromate, and potassium dichromate, and of mercuric chloride with ammonium chromate; but in none of these experiments were we successful.

The salt numbered 1, and given by Richmond and Abel the formula $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2 \cdot \text{H}_2\text{O}$, is easily prepared. The salts represented in it are dissolved together in equivalent proportions, and from the concentrated solution the double compound is deposited in large showy crystals. As obtained by us, however, it was anhydrous. As formulated by Richmond and Abel, it should contain 3.33 per cent of water; but, as obtained by us, it lost no weight even after long heating at 150°. An estimation of chromium gave us 19.80 per cent. The theoretical percentage for an anhydrous salt is 19.88; for a monohydrated compound, 19.22.

From the mother-liquor of the foregoing compound, Richmond and Abel obtained the salt which we have numbered 2. This body we did not obtain. Various attempts were made to prepare it, but all were unsuccessful. Several crops of the original salt were deposited in

* Proceedings of the American Academy, p. 1639.

succession, and finally some orange-red laminæ were secured, which were neither ammonium dichromate nor either of the double salts above referred to. They were, however, contaminated with mercuric chloride, and were not in sufficient quantity for purification and complete analysis. To the mother-liquor from them ammonia was added. A heavy dirty yellow precipitate was at first formed, which re-dissolved in an excess of the precipitant. The solution thus obtained deposited dark clove-brown granular crystals, also in quantity insufficient for thorough analysis. They were insoluble in cold water, but boiling water decomposed them, with separation of a yellow basic chromate of mercury. At 150° the crystals lost 1.68 per cent of their weight, and at 200° 16.66 per cent. 17.04 per cent of chromium, 8.89 of ammonia, and 43.70 of mercury were found in them, but no chlorine. From this meagre evidence we can deduce no probable formula; but we suggest the body to be a double salt of an ammonium chromate, with a chromate of one of the mercurammonium bases.

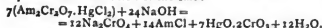
Upon adding a caustic alkali to a solution of the salt $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2$, a yellow precipitate was thrown down, which proved to be a basic chromate of mercury. From hot solutions precipitates were formed of variable composition; but from cold solutions a compound was deposited consisting definitely of the salt $7\text{HgO} \cdot 2\text{CrO}_3$. Our analytical results were as follows, in percentages:—

| | Ammonia Ppt. | Soda Ppt. | Theoretical. |
|-------|--------------|-----------|--------------|
| Cr .. | 6.08 | 6.09 | 6.14 |
| Hg .. | 80.74 | 81.41 | 81.77 |

The same compound was partially studied in this laboratory two years ago by Miss Helena Stallo, but her results were not published. She obtained the following percentages of chromium:—

| | NH_4OH Ppt. | NaOH Ppt. | KOH Ppt. |
|-------|-----------------------------|--------------------|-------------------|
| Cr .. | 6.09 | 5.96 | 6.07 |

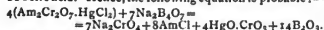
These figures are interesting, inasmuch as the same compound was prepared by a different process by Geuther,* whose results were afterwards discredited by Freese.† According to the latter chemist there is probably but one basic mercuric chromate, viz., the tribasic compound $3\text{HgO} \cdot \text{CrO}_3$. Our results confirm Geuther's, and from another line of investigation. The following equation represents the formation of the salt:—



The addition of a solution of borax to a solution of the salt $\text{Am}_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2$ also produces a yellow precipitate. This product agrees fairly with the formula $4\text{HgO} \cdot \text{CrO}_3$, as the subjoined figures show:—

| | Found. | Theoretical. |
|-------|--------|--------------|
| Cr .. | 5.10 | 5.38 |
| Hg .. | 82.34 | 82.88 |

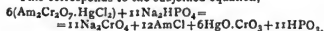
The filtrate from this precipitate, upon concentration, gave white scaly crystals, which proved upon analysis to be boric acid. Hence, the following equation is probable:—



If, instead of borax, hydro-disodic phosphate be used for a precipitant, still another basic chromate is thrown down. It agrees approximately with the formula, $6\text{HgO} \cdot \text{CrO}_3$.

| | Found. | Theoretical. |
|-------|--------|--------------|
| Cr .. | 4.07 | 4.04 |
| Hg .. | 86.43 | 85.96 |

This corresponds to the subjoined equation,—



The last term in the equation was not verified, but it is suggested by the actual formation of boric acid in the previous case.

In conclusion, our results establish the existence of the basic chromate, $7\text{HgO} \cdot 2\text{CrO}_3$, and render the existence of two other basic chromates of mercury highly probable. All three are thrown down definitely from cold solutions, and all are more or less changed by boiling.—*American Chemical Journal*.

SOME NEW COMPOUNDS OF PLATINUM.

By F. W. CLARKE AND MARY E. OWENS.

THE action of potassium cyanate upon the compounds of platinum seems never to have been systematically studied. We have begun an investigation upon the subject, and now present some of our earlier results.

When cold alcoholic solutions of platinum tetrachloride and potassium cyanate are mixed, a pale buff-yellow precipitate is thrown down. If the mixture is heated, this precipitate undergoes partial decomposition, and what is apparently metallic platinum separates out. By filtration, washing with alcohol, and drying at ordinary temperatures over sulphuric acid, the precipitate may be obtained in a stable condition. It is soluble in water, but completely insoluble in alcohol, and its aqueous solution decomposes upon boiling. Analysis gives the following percentages, which agree with the novel formula $\text{K}_2\text{PtCl}_5(\text{CNO}) \cdot \text{H}_2\text{O}$.

| | Found. | Theoretical. |
|---------------------|--------|--------------|
| Pt .. | 38.41 | 38.6 |
| Cl .. | 34.79 | 34.74 |
| K .. | 15.08 | 14.67 |
| C .. | 2.47 | 2.35 |
| H ₂ O .. | 3.76 | 3.52 |

For want of sufficient material, nitrogen was not estimated. The presence of the cyanic molecule in the compound is, however, unquestionable.

By the action of potassium cyanate upon the green salt of Magnus, $\text{PtN}_2\text{H}_6\text{Cl}_2$, new compounds are formed, apparently of great complexity. The Magnus salt was prepared by the addition of a solution of potassium chloroplatinate to aqueous ammonia. A pure product is thus almost immediately formed, whereas the methods hitherto laid down for the preparation of this body gave us very unsatisfactory results. The Magnus salt dissolves readily in a hot aqueous solution of the cyanate, yielding a dark brown solution; which, concentrated over the water-bath to its crystallising point, deposits pale yellow needles. From the mother liquor, beautiful clusters of brown needles were obtained. The yellow salt contained platinum, potassium, ammonia, water, and carbon; the platinum amounting to 43.93 per cent. In the brown crystals, ammonia, platinum and chlorine were found. Both salts are to be systematically investigated.

One other new salt was incidentally obtained by us. The well-known potassium sulpho-cyano-platinate is prepared by the action of potassium sulpho-cyanate upon the chloro-platinate. Happening to have a quantity of the strychnia chloro-platinate on hand, we dissolved it in potassium sulpho-cyanate. The blood-red solution, which was obtained after short boiling, deposited on cooling a brilliant red crystalline precipitate. This proved to be the strychnia salt analogous to the potassium sulpho-cyano-platinate, and gave percentages of platinum and sulphur agreeing with the formula $2(\text{C}_2\text{H}_5\text{N}_2\text{S}_2\text{O}_2)_2\text{H}_2\text{PtCyS}_6$.

| | Found. | Theoretical. |
|-------|--------|--------------|
| Pt .. | 14.12 | 14.49 |
| S .. | 13.76 | 14.01 |

Doubtless other sulpho-cyano-platinates of alkaloïds may be easily obtained.

* *Ann. Chem. Pharm.*, 106, 244.

† *Poggend. Annal.*, 140, 7.

The investigation of the products resulting from the action of cyanates upon platines is to be followed up at an early day. The whole subject of the reactions between cyanates and salts of the various metallamines and metallammoniums bids fair to yield results of considerable interest.—*American Chemical Journal*.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 2, 1882.

Prof. A. W. WILLIAMSON, Vice-President, in the Chair.

The following certificates were read for the first time:—H. S. Billing, W. G. Crook, W. Fowler, N. Graham, A. Hartley, A. Hill, F. Vacher.

The CHAIRMAN then called on Dr. ODLING to deliver his lecture "On the Unit Weight and Mode of Constitution of Compounds." The lecturer said that it had been found useful to occasionally bring forward various points of chemical doctrine, on which there were differences of opinion, to be discussed by the Society. On this occasion he wished not so much to demonstrate certain conclusions, or to make a declaration of his opinions, as to invite discussion and a thoughtful consideration of questions of importance to chemists. Originally three questions were proposed:—First, Is there any satisfactory evidence deducible of the existence of two distinct forms of chemical combination (atomic and molecular)? Second, Is the determination of the vapour density of a body alone, sufficient to determine the weight of the chemical molecule? Third, In the case of an element forming two or more distinct series of compounds, e.g., ferrous and ferric salts, is the transition from one series to another necessarily connected with the addition or subtraction of an even number of hydrogenoid atoms? He would, however, limit himself to the first of these questions, at the same time the three questions were so closely associated with one another that in discussing the first it was difficult to know where to begin. The answer to this question (Is there any satisfactory evidence deducible of the existence of two distinct forms of chemical combination?) depends materially on the view we take of the property called in text-books valency or atomicity; and before discussing the question it is important to have a clear idea of what these words valency and atomicity really mean. It is necessary, too, to start with some propositions which must be taken for granted. These propositions are:—First; that in all chemical changes, those kinds of matter which we commonly call elementary, do not suffer decomposition. Second. That the atomic weights of the elements as received, are correct, i.e., that they do really express with great exactitude the relative weights of the atoms of the individual elements. If we accept these two propositions, it follows that hydrogen can be replaced atom for atom by other elements not only by the halogens but by alkali metals, &c. Hydrogen is, it may here be remarked, an element of unique character; not only can it be replaced by the elements of the widely different classes represented by chlorine and sodium, but it is the terminal of the series of paraffins C_nH_{2n+2} ; C_2H_6 , C_3H_8 , C_4H_{10} , &c. The third proposition which must be taken for granted is, that the groups of elements $C_{12}H_5$, CH_3 , behave as elements and that these radicals, ethyl, methyl, &c., do not suffer decomposition in many chemical reactions.

Now as to valency or atomicity, accepting the received atomic weights of the elements, it is certain that there are at least four distinct types of hydrogen compounds represented by CH_4 , OH_2 , NH_3 , CH_2 . The recognition of these types, and their relations to each other as types, was one of the most important and best assured advances made

in theoretical chemistry. When we compare the formula of water with that of hydrochloric acid, we find that there is twice as much hydrogen combined with one atom of oxygen as there is combined with one atom of chlorine; and in a great many other instances, we find that we can replace two atoms of chlorine by one atom of oxygen, so that we get an idea of the exchangeable value of these elements, and we say that one atom of oxygen is worth two of chlorine or is bivalent; similarly, nitrogen is said to be trivalent. The meaning attached to the word valency is simply one of interchangeability, just as we say a penny is worth two halfpennies or four farthings. The question next arises is the valency of an element fixed or variable? If the word be defined as above, it is absolutely certain that the valency varies. Thus, tin may be trivalent, $SnCl_2$, or tetravalent, $SnCl_4$. Accordingly elements have been classed as monads, dyads, triads, &c. The lecturer objected most strongly to the word atomicity; he could not conceive of one atom being more atomic than another; he could understand the atomicity of a molecule or the equivalency of an atom, but not the atomicity of an atom; the expression seemed to him complete nonsense. He next considered the possibility of assigning a fixed limit to this valency or acidity of an atom, and concluded that the acidity was not absolutely fixed, but was fixed in relation to certain elements, e.g., C never combines with more than four atoms of H; O never more than two atoms of H, &c. The acidity of an element when combined with two or more elements is usually higher than when combined with only one, e.g., NH_3 , NH_4Cl . The term capacity of saturation may be used as a synonym for acidity, if care be taken to distinguish it from other kinds of saturation, such as an acid with an alkali, &c. Acidity is, however, quite distinct from combining force; the latter is indicated by the amount of heat evolved in the combination.

The lecturer then proceeded to criticise a statement commonly found in text-books, that chemical combination suppresses altogether the properties of the combining bodies. The reverse of this statement is probably true. To take the case commonly given of the combination of copper and sulphur when heated; this is good as far as it goes, but there are numerous instances, as ClI , SSe , &c., where the original properties and characters of the combining elements do not completely disappear. The real statement is that the original properties of the elements disappear more or less, and least when the combination is weak and attended with the evolution of a slight amount of heat, and in every case some properties are left which can be recognised. So with reference to the question of atomic and molecular combination, as atomic combination does not necessarily produce change it does not differ in this respect from what is usually called molecular combination.

The lecturer then referred to an important difference in the acidity of chlorine and oxygen. Chlorine can combine with methyl or ethyl singly. Oxygen can combine with both and hold them together in one molecule. The recognition of this fundamental difference between chlorine and oxygen, this formation of double oxides as opposed to single chlorides, marks an epoch in scientific chemistry.

The lecturer then considered the subject of chemical formulae; it is the bounden duty of every formula to express clearly the number of atoms of each kind of elementary matter which enters into the constitution of the molecule of the substance. A formula may do much more than this. If we attempt to express too much by a complex formula we may veil the number of atoms contained in it. This difficulty may be avoided by using two formulae, a synoptic formula giving the number of atoms present, and a complex formula perhaps covering half a page giving the constitution of the molecule. But between the purely synoptic formula and the very elaborate formula there are others—contracted formulae—which labour under the disadvantage, as a rule, of being one-sided, and so create a false impression as to the nature of

the substance. Thus, for instance, to take the formula of sulphuric acid, H_2SO_4 . This suggests that all the oxygen is united to the S; $(\text{HO})_2\text{SO}_2$ suggests that two atoms of hydroxyl exist in the molecule; then, again, we might write the formula HSO_3OH , or H_2OSO_3 . All of these are justifiable, and each might be useful to explain certain reactions of sulphuric acid, but to use one only creates a false impression. The only plan is to use them variously and capriciously, according to the reaction to be explained. Again, ethyl acetate may be written—



Or condensed—



Or $\text{H}_5\text{C}_2\text{O} \cdot \text{C}_2\text{H}_5\text{O}$, or $\text{H}_5\text{C}_2 \cdot \text{C}_2\text{H}_5\text{O}_2$. Now each of these two latter formulae is a partial formula, each represents a one-sided view; it is justifiable if you use both, but unfair if you use only one.

We now come to the question as to the existence or non-existence of two distinct classes of compounds, one in which the atoms are combined directly or indirectly with each other, and the other in which a group of atoms is combined as an integer with some other group of atoms, without any atomic connection, by so-called molecular combination. These two modes of combination are essentially distinct. The question is not one of degree. Are there any facts to support this theory that one set of compounds is formed in one way, another in a different way?

Take the case of the sulphates: Starting with SO_3 , we can replace one atom of O by HO , and obtain $\text{SO}_2(\text{HO})_2$ or H_2SO_4 ; replacing a second atom, we get $\text{SO}(\text{HO})_3$, or H_2SO_5 glacial sulphuric acid, a perfectly definite body corresponding to a definite class of sulphates, e.g., H_2MgSO_5 , ZnSO_5 , &c. By replacing the third atom of O we get $\text{S}(\text{HO})_4$ or H_2SO_6 ; this corresponds to a class of salts, gypsum, H_2CaSO_6 , &c. These are admitted without dispute to be atomic compounds. Are we to stop here? We may write the above compounds thus— H_2SO_4 , H_2SO_5 , H_2SO_6 , H_2SO_7 . If we measure the heat evolved in the formation of the two latter compounds, it is, for $\text{H}_2\text{SO}_5 + \text{H}_2\text{O}$, 6'272; $\text{H}_2\text{SO}_6 + 2\text{H}_2\text{O}$, 3'092. But if we now take the compound $\text{H}_2\text{SO}_4 + 3\text{H}_2\text{O}$ we have heat evolved 1'744; so we can have $\text{H}_2\text{SO}_4 + 3\text{H}_2\text{O}$, &c. Where are we to draw the line between atomic and molecular combination, and why? It comes to this: All compounds which you can explain on your views of atomicity are atomic, and all that you cannot thus explain are molecular. Similarly with phosphates, arsenates, &c. In all these compounds it is impossible to lay one's finger on any distinction as regards chemical behaviour between the compounds called atomic and those usually called molecular.

Two points remain to be mentioned: The first is the relationship between alteration of acidity and two series (ous and ic) of compounds. Tin is usually said to be dyad in stannous compounds and a tetrad in stannic compounds, but in a compound like SnCl_4AmCl , is not tin really a tetrad?—



and yet it is a stannous compound, and gives a black precipitate with H_2S ; so that valency does not necessarily go with the series. The second point is that an objection may be urged, as, for example, in ammonium chloride (the lecturer stated above that here N was a pentad, the addition of the chlorine having caused the N to assume the pentadic character), it may be said, why should you

not suppose that it is the chlorine which has altered its valency, and that the compound should be written—



There is something to be said for this view, but on the whole the balance of the evidence is in favour of nitrogen being a pentad.

In conclusion the lecturer stated that his principal object was to direct the attention of chemists, and especially of young chemists, to the question: Is there or is there not any evidence derived from the properties, the decompositions, or the relative stabilities of substances to warrant us in believing that two classes of compounds exist, one class in which there is interatomic connection alone, and another in which the connection is molecular.

The CHAIRMAN said that at that late hour it was hardly possible to discuss the thoughtful and able address to which the Fellows had just listened. On his own behalf he might say that he had for some time past given much thought to the question as to how far certain theories were statements of facts, and he had come to the conclusion that it would be better to get rid of such phrases as molecular combination, &c., which were not statements of facts. Such phrases seemed, like the blinkers on a horse, only to shut out certain objects which we could not explain. It was better to refer to the unknown as unknown, and not give some fine scientific name to a reaction which we did not understand. The mind was only too ready to become satisfied with such a name and to accept the word as giving some account of the fact, and thus the motive for investigation is diminished, and the progress of knowledge hindered. He was inclined, too, to dispense with new words for old things, and he would prefer to use the old word "value" instead of Adicity or Valency. It was undesirable, too, to class elements as monads, dyads, &c., as their value varied under different conditions. Iodine, for instance, was usually called a monad; it certainly was not. In its most stable compounds it was a pentad or heptad; only in the unstable HI was it a monad.

Dr. ARMSTRONG said that according to L. Meyer there was reason to believe that some of the non-metallic elements behaved in different ways, e.g., the halogens when combined with the metals behaved as monads; with the non-metals, as polyads. So that there might be two different methods of combination. For instance, in ammonium chloride the N might be combined with the three atoms of H, as in ammonia, and the HCl add itself on—



Again that the compound SnCl_4AmCl gave a black precipitate with sulphuretted hydrogen seemed to him no proof that the compound was a stannous salt; it might be stannic and be decomposed by the sulphuretted hydrogen.

Dr. FRANKLAND must express his admiration of the excellent and logical discourse of Dr. Odling, but must confess that he was somewhat taken at a disadvantage by the ingenious title under which the lecturer had concealed the real subject of his lecture. He thought the term "atomicity" had something to be said for it; it lends itself, too, readily to the English language. As regards the gradation between atomic compounds and those usually called molecular, it must be remembered that in all departments of Nature it was difficult to fix the limit, as between plants and animals. As regards the very ingenious and forcible instances of the continued elimination of heat by the union of sulphuric acid and water, he would ask where are we to stop? He had carried the experiments down to moistening a piece of blotting-paper with pure water, and surely that was not a case of atomic combination, yet a certain amount of heat was evolved. He would protest, too,

against the capricious use of formulæ. It was difficult enough for students to follow the constitution of substances when the formulæ were on a uniform plan, and surely (though his contention might be unscientific) it would be doubly difficult if the formulæ were constantly changing.

Dr. ONLINO said that though it would be easier for a student to use one form of partial formulæ he would take only a one-sided view of the substance, and surely it was worth the trouble to look at a substance from all sides rather than have a false impression by looking at it from one side only. As regards the question of gradation, he had pointed out that the difference between atomic and molecular compounds was one not of degree, but that the compounds must be quite distinct, and ought to show different reactions. As to the stannous chloride, he would take another example, which was still more clear. The compound $\text{Fe}_2\text{Cl}_2\text{KCl}$, which was green and was evidently a ferrous salt, yet the iron was there in the same condition as regards valency as in Fe_2Cl_6 .

After a few remarks from Dr. Wright and Mr. Cross, The Society adjourned to February 16, when the following papers will be read:—"On the Luminous Combustion of Ether at Temperatures below Redness," by W. H. Perkin; "Contributions to our Knowledge of the Composition of Alloys, for the most part Ancient," by Dr. Flight; "On the Preparation of Pure Nitrogen, and on the Action of Nitrogen and Hydrogen on Meteoric Silicates," by Dr. Flight; "On the Action of Sodium Carbonate and Hydrate on Felspar and Wollastonite," by Dr. Flight; "On Benzyl-phenol," by E. H. Rennie; "On the Buxton Thermal Water," by J. C. Thresh; "On Retrograde Phosphates," by T. F. Lloyed.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, February 6th, 1882.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair.

Sidney Biddell, Esq., M.A., the Earl of Dysart, and Mrs. Archibald Hamilton were elected Members of the Royal Institution.

Report from the Managers.—The following Resolution passed by the Committee of Managers at a Special Meeting held on December 16th, 1881, was read and adopted by the Members:—

1. The Board of Managers of the Royal Institution received with great regret Mr. Warren De la Rue's letter of December 3, 1881, addressed to Professor Tyndall, announcing that the state of his health compelled him to resign the office of Honorary Secretary to the Royal Institution.
2. The Managers fully appreciated the considerate offer made by Mr. De la Rue to continue in the post of Honorary Secretary for some time longer, if such a course were deemed desirable for the advantage of the Institution; but they believed it to be their duty to secure for Mr. De la Rue the immediate release from the cares of office which seemed indispensable.
3. The Managers trust that Mr. De la Rue may be enabled, after due rest and medical treatment, to resume those scientific pursuits in which so much of his life has been spent, and to the prosecution of which by others so much generous assistance has always been extended by him.
4. The Managers cannot bid farewell to Mr. De la Rue, as Honorary Secretary to the Royal Institution, without tendering to him their warmest thanks for the ability, zeal, and liberality with which he has aided the Royal Institution while filling that important office.
5. The devotion of Mr. De la Rue's time and attention to the interests of the Institution will always be

remembered with gratitude in connection with the services of other distinguished men, many of whose names, like his own, belong to the history of Science—a history to which the work done in the Royal Institution has made such signal contributions.

William Bowman, Esq., LL.D., F.R.S., was elected Honorary Secretary, and Warren De la Rue, Esq., M.A., D.C.L., F.R.S., was elected Manager.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

Thirteen candidates for membership were proposed for election.

CORRESPONDENCE.

PHOSPHORESCENCE.

To the Editor of the Chemical News.

SIR,—Captain Abney, although a noted photographic scientist, is certainly not *au courant* with the phenomenon of phosphorescence, since he has lately brought before the members of the Physical Society an account (CHEMICAL NEWS, vol. xlv., p. 52) of some experiments in connection with the above phenomenon, most of which have been known for at least thirty years.

If your readers will turn to vol. i., p. 196, of "Gmelin's Handbook of Chemistry," published in 1848, they will find the following:—"Phosphori which have been rendered luminous by colourless light cease to shine much sooner in red light than in the dark; and instantaneously when exposed to red light concentrated by a lens.—(Seebeck)." "Light transmitted through blue glass makes Canton's phosphorus almost as luminous as colourless light concentrated by a lens; behind red glass, on the contrary, the phosphorus not only fails to acquire luminosity, but ceases to shine, when previously irradiated, much sooner than it would if placed in the dark.—(Seebeck)."

Of course, in answer to this, the Captain might say that Balmain's paint was not known thirty years ago; but if he will refer to vol. xli., p. 137, of the CHEMICAL NEWS, he will see the following, quoted from a lecture delivered before the Society of Arts, in March, 1880, by Professor Heaton, on "Balmain's Luminous Paint":—"If the experiment is carried on for a long time with a very intense spectrum, another effect which we could not have anticipated is observed in the lowest layer, which has previously been made luminous. The violet and ultra-violet rays increase the luminosity, as we might have expected, but the yellow and red rays not only do not add to the luminosity, but actually take away the light previously present. Another experiment will show this effect more quickly. Here is a sheet, at present luminous: I cover half of it with opaque cardboard, and the other half with yellow glass, and then burn a piece of magnesium in front of it. See the result. The rays which passed through the yellow glass have taken nearly all the light out of that half of the card, while the light on the other remains unimpaired."

In conclusion I may state that I was present at the lecture referred to, and saw this experiment successfully carried out.—I am, &c.,

A. J.

Spontaneous Combustion of Bengal Lights.—J. Clouet.—The author shows that the spontaneous explosion of mixtures containing potassium chlorate along with sulphur is generally due to a trace of sulphuric acid present as impurity in the latter substance, and he agrees with M. Du Moncel in rejecting the theory which ascribes such accidents to electric action.—*Journal de Pharmacie*,

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 2, January 7, 1882.

Methods of Coppering Cast-Iron in Use at Val-d'Osne.—M. Mignon and Rouart.—The authors point out a distinction between their process and that of M. Weil. The latter uses a bath of copper sulphate rendered strongly alkaline, with an organic acid added to prevent the precipitation of copper oxide. M. Mignon and Rouart, on the contrary, use a distinctly acid solution of a double salt of copper and any alkali with an organic acid.

Certain Consequences of the Principle of Gauss in Electrostatics.—M. Croulebois.—The author finds that in a system of fixed conductors, where two distinct states of equilibrium are considered, the sum of the products of the initial charge of each conductor and of the variation of its potential from one state to another is equal to the sum of the products of the initial potential, and of the variation of the charge. When conductors, kept at constant potentials, are left to their mutual actions, the energy of the system tends towards a maximum.

A Transmitter of Sounds with a Sounding-Board fitted with Strings.—M. Bourbouse.—If a sound is produced at a certain distance from the sounding-board (*table d'harmonie*) of a piano, it is known that this board, as well as the strings which are in unison with the sound produced, or with one of its harmonics, enter into vibration. The author finds, on applying a microphone to such a board, that the sound transmitted in a circuit containing a telephone is considerably strengthened without any alteration either in its distinctness or in its quality, and upon this principle he has constructed a very sensitive transmitter.

Measure of the Internal Resistance and of the Electromotive Force of Electric Machines in Action.—G. Cabanellas.—The author uses a machine as a source making N turns per unit of time in a circuit of an arbitrary resistance. He observes by means of common galvanometers the intensity I , and the difference of potential ϵ at the limits of the machine. He then employs the machine as a motor receiving a current from any source; he regulates the friction by a brake placed on the axle of the machine so as to obtain the intensity I , and he varies the difference of potential absorbed by the machine till he obtains the speed N . He arrives at it either by acting upon the electromotor source and the resistance of the connection, or upon one of them only. He observes, then, the difference of the potential at ϵ' , E , and ϵ , being the electric elements, and has the two equations:—

$$E = \epsilon + rI, \quad E = \epsilon' - rI.$$

Whence he deduces the values:—

$$E = \frac{\epsilon' + \epsilon}{2}, \quad r = \frac{\epsilon' - \epsilon}{2I}.$$

Note on the Theory of the Formates.—Extract from a letter by M. Maumené.—The author contends that the results obtained by M. Riban are perfectly explained by his general theory.

Thermic Researches on the Sulphur Oxy-chlorides.—J. Ogier.—A thermo-chemical study of the chlorides of sulphuryl, thionyl, and pyro-sulphuryl.

Carbonic Ether of Borneol.—A. Haller.—The ether in question, $C_{21}H_{34}O_2$, forms very light and white hexagonal tables, insoluble in water and alkalies, soluble in boiling alcohol, in ether, chloroform, benzol, and glacial acetic acid. It melts at 215° , and sublimes without de-

composition. Its rotatory power varies with that of the borneol which has served for its preparation.

Formation of Bases of the Quindecic Series in the Distillation of Cinchonine with Potassa.—Göschner de Coninck.—The author has isolated a tetra-hydroquinoleine, $C_{20}H_{22}N$, an intermediate product between the quinoleic and the pyridic series.

Terpine.—W. Walitzky.—The author has obtained and studied a derivative of terpine, $C_{10}H_{16}$, which he names terpine.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 13, No. 12.

The Specific Heat and the Expansion of the Solid Elements.—H. F. Wiebe.—The total quantity of heat is according to the law of Dulong and Petit inversely proportional to the atomic weight, but shows when considered in itself no especial uniformities. But a regular relation appears, at least in certain groups, as soon as the entire heat introduced into a body up to the melting-point is taken into consideration, as the author shows in a table.

The Expansion and the Molecular Volume of Organic Liquids.—H. F. Wiebe.—The density of the fatty acids and their ethers may be calculated according to the formula—

$$\delta = \frac{A}{2(n+1) \cdot 3'542}.$$

A signifies the molecular weight, and n the number of atoms in the molecule.

Amido-lactic Acid.—P. Melikoff.—This compound is formed by the action of ammonia upon α -chloro-lactic ether.

Preliminary Communication on the Behaviour of Phosphates with Ammonium Citrate.—A. Gruppe and B. Tollens.—The authors examine two points: upon what does the solvent action of ammonium citrate depend, and whether there exists an essential difference in the behaviour of this liquid with different phosphates; and, secondly, is the determination of phosphoric acid by direct precipitation with magnesia mixture from this solution sufficiently accurate? As regards the first question they conclude that the phosphates dissolved are converted into calcium citrate and ammonium phosphate. The differences of solubility do not depend on any essential feature. The results are sufficiently accurate if the magnesia mixture and the phosphoric acid are in certain proportions. A re-precipitation is, however, needed. Three times as much magnesia mixture should be used as the calculated quantity. A certain quantity of lime is also thrown down, and if the proportion of mixture is too great an excess of magnesia may be found in the precipitate.

Action of Iodine upon the Silver Salts of Certain Bibasic Acids of the Fatty Series.—K. Birnbaum and J. Gaier.—The silver and iodine combine, and the acid residue is resolved into anhydride and free oxygen.

Contributions to the Solution of the Question of the Constitution of Sulphones.—R. Otto.—An extensive memoir, not admitting of useful abstraction.

Synthesis of the Ethers of the Thiosulphonic Acids.—R. Otto.—The author caused an alcoholic solution of bromethyl to act upon potassium thio-benzol-sulphonate. The product was ethyl-phenyl-disulphoxide.

Sulphuretted Benzyl Compounds.—R. Otto and R. Lüders.—An examination of benzyl-sulph-hydrate, di-benzyl-sulphon, thio-benzoyl-benzyl-ether, benzyl-sulphonic acid, and the behaviour of potassium benzyl-sulphonate with melting potash.

Behaviour of Mercury- and Lead-ethyl-mercaptides at Elevated Temperatures.—R. Otto.—The mercury compound is resolved at 180° to 190° into metallic mercury and ethyl-disulphide. The lead compound at the same temperature yields lead sulphide and ethyl sulphide.

Action of Sulphuric Acid upon Aromatic Mercaptans.—R. Otto.—Phenyl-sulph-hydrate is entirely converted by sulphuric acid at common temperatures into phenyl disulphide without the formation of by-products.

The so-called Toluol-meta-sulphonic Acid of Beckurt.—R. Otto.—This body is found to be a mixture of the para- and ortho-compounds.

Carbonic Oxide Hæmo-globin.—Th. Weyl and B. von Anrep.—The authors discuss the behaviour of hæmo-globin oxide and of carbonic oxide hæmo-globin with oxidising agents, and the reduction of methæmo-globin. Oxygen methæmo-globin and carbonic oxide methæmo-globin are found to be distinct bodies, though their spectroscopic behaviour is similar.

Constitution of Tetra-nitro-diphenyl-carbamide.—S. M. Losanich.—A theoretical paper.

Substitutional Introduction of Phenyl Residues.—V. Merz and W. Weith.—Not suitable for abstraction.

Diphenic Anhydride.—C. Graebe and C. Mensching.—The authors treat of the formation and preparation of diphenic anhydride, its decomposition when heated, its phthalic acids, and its behaviour with phosphorus chloride.

Preliminary Communication on Certain Derivatives of Orcine.—J. Stenhouse and C. E. Groves.—An examination of the views of Liebermann and Dittler on the constitution of penta-chlor-orcine.

Schizomycetic Fermentation.—A. Fitz.—Experiments on the fermentation of propionic acid and the normal valerianic acid obtained from calcium lactate.

Double Salts of the Lower Fatty Acids.—A. Fitz.—Not susceptible of useful abstraction.

Certain Remarks on the Vapour-density of Iodine.—J. M. Crafts.—Already noticed.

Thermo-Chemical Researches on the Theory of the Carbon Compounds.—J. Thomsen.—The author gives his results in the form of tables.

Furfural.—E. Fischer.—An examination of furoine, furil, furil-octo-bromide, dibrom-furil, and benz-furil.

Sequel to Homotropin.—A. Ladenburg.—The melting-point of homotropin is from 95° to 98° 5'. Its composition is $C_{16}H_{21}NO_2$.

Determination of Nitrogen in Organic Substances.—C. E. Groves.—This paper requires the accompanying illustration.

Occurrence of Free Sulphur in the Dry Distillation of Coal Tar.—A. Kehlstadt.—Sulphur has been thus deposited at the Tar and Ammonia Works of C. Kurtz and Sons, Liverpool.

Transformation of α -Naphthyl-amine into α -Naphthyl-methyl-ether.—A. Hantzsch.—This transformation is a proof that the analogy between the derivatives of benzol and of naphthaline is less complete than is believed.

Transformations of Sulpho-cyan-methyl under the Influence of High Temperatures.—A. W. Hofmann.—At the temperature of 180° a part of the methyl-sulpho-cyanate is converted into methyl-thio-cyanate.

Archives Néerlandaises des Sciences Exactes et Naturelles.
Tome xvi., Livraison 5.

The Density and the Coefficient of Expansion of Diethyl-amin.—A. C. Oudemans, Jr.—The author gives a tabular view of the density of diethyl-amin at temperatures ranging from 0° to 55°. The value at the former figure is 0.7262, and at the latter 0.6680. Tables are also given for the change of volume.

Crystalline Form of α -Dinitro-dimethyl-aniline.—A. P. N. Franchimont.—Not capable of reproduction.

Journal de Pharmacie et de Chimie.
November, 1881.

On Levulose.—MM. Jungfleisch and Lefranc.—Levulose if moistened with alcohol and exposed to the air is deliquescent, but if freed from alcohol it is very slightly hygroscopic. It melts at 95°, and if heated to 100° it loses increasing quantities of water and yields ethereal derivatives. Its rotatory power deserves a special attention as presenting interesting peculiarities. It varies very rapidly with temperature, and notably with the dilution of the liquids in which it is observed.

December, 1881.

New Process for the Rapid Analysis of Opium.—MM. Portes and Langlois.—Take from an average sample 7 grms. of the opium; weigh out 3 grms. of slaked lime, and measure 70 c.c. of distilled water. Mix the opium and the lime very carefully, adding the water in small fractions, and leave the mixture for half an hour, stirring from time to time. Throw the whole upon a filter, and collect 53 c.c. of the liquid in a small glass provided with a lid. Add to the liquid 10 c.c. of ether, and agitate. Dissolve in the liquid 3 grms. ammonium chloride, agitating to promote solution, and let settle for two hours. Decant off the ether, put a fresh quantity in its place, agitate, and decant again. Collect the precipitate of morphia upon a filter without folds and 10 c.m. in diameter, and wash the precipitate and the vessel with a few c.c. of cold distilled water. Wash the precipitate into the vessel which has served for precipitation by means of 50 c.c. of distilled water. Add 5 c.c. of dilute sulphuric acid, containing 1.617 per cent by measure of SO_4H_2 , and 4 drops of neutral litmus. If the liquid becomes red the opium does not contain 10 per cent of morphine, but if it is blue it exceeds the normal standard. To find the deficiency or the excess: if the opium is too weak, drop in with the burette a standard alkaline solution till the liquid is neutralised; if too strong, an acid liquid is dropped in, in a similar manner.

MEETINGS FOR THE WEEK.

- MONDAY, 13th.**—London Institution, 5.
— Medical, 8.30.
— Society of Chemical Industry, 7.30. "Waste Products and Undeveloped Processes," by C. T. Kingzett. "A New Source of Potash Alum," by J. Spiller.
— Society of Arts, 8. "Recent Advances in Photography," by Capt. W. de W. Abney, F.R.S.
TUESDAY, 14th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Photographic, 8. (Anniversary.)
— Royal Institution, 8. "The Mechanism of the Senses," by Prof. J. G. McKendrick.
WEDNESDAY, 15th.—Society of Arts, 8. "The Art of Turning," by P. N. Hasluck.
— Meteorological, 7.
THURSDAY, 16th.—Royal, 4.30.
— London Institution, 7.
— Royal Society Club, 6.30.
— Royal Institution, 8. "Geographical Distribution of Animals," by Dr. P. L. Sclater.
— Chemical, 8. "On the Luminous Combustion of Ether at Temperatures below Redness," by W. H. Perkin. I. "Contributions to our Knowledge of the Combustion of Alloys, for the Most Part Ancient." II. "On the Preparation of Pure Nitrogen and on the Action of Nitrogen and Hydrogen on Meteoric Silicates." III. "On the Action of Sodium Carbonate and Hydrate on Felspar and Wollastonite," by Dr. Flight. "Benzyl-phenol (Part II)," by E. H. Remie. "On the Biston Thermal Waters," by J. C. Thresh. "On Retrograde Phosphates," by F. J. Lloyd. "On the Dissociation of Chlorine," by W. Percy Smith.
FRIDAY, 17th.—Royal Institution, 8. "Breathing of Fishes," by Professor J. G. McKendrick, 9.
— Society of Arts, 8. "The Depreciation of Silver as it Affects India," by J. M. Maclean.
— Geological, 8. (Anniversary.)
SATURDAY, 18th.—Royal Institution, 5. "The Iliad and Odyssey," by W. Watkins Lloyd.

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THE CHEMICAL NEWS

VOL. XLV. No. 1160.

NOTE ON A FILTERING SYPHON FOR THE SEPARATION OF ETHER, &c.

By C. J. H. WARDEN, Bengal Medical Staff,
Professor of Chemistry, Calcutta Medical College.

IN separating quinine and amorphous alkaloid from the mixed cinchona alkaloids by agitation with ether, the subsequent removal of the ethereal layer from undissolved alkaloid and from the aqueous stratum is an operation of some little difficulty. If the ether be decanted off, or taken up by a pipette, small quantities of solid matter, as well as watery fluid, are also likely to be removed, while the ordinary separating funnels do not facilitate the operation. To obviate these difficulties the following simple apparatus was devised, and has been found to answer well:—

The apparatus is essentially a filtering siphon, and consists of a siphon-shaped tube of thick glass, of small bore, on the shorter limb of which a small funnel has been blown, which is provided with a narrow projecting lip, and with a ground flat rim, while the other end of the larger limb is drawn out. The shorter limb is mounted on a cork, in which there is a second aperture, which carries a small bent tube. The cork fits the bottle in which the operation of agitation with ether has been conducted, and which should preferably be long and narrow.

To use the apparatus, the funnel is lightly stuffed with a few fragments of cotton-wool, and a piece of filter-paper tied over the mouth, the flange preventing it from slipping, and the superfluous paper cut off short. The funnel is then introduced a short distance below the surface of the ether, and the cork fixed. The apparatus has now some-what the appearance of a wash-bottle, save that the tube from which the liquid escapes is three or four times the length of the tube which is immersed in the liquid. On gently blowing through the open end of the small tube—which may conveniently have a piece of india-rubber tubing attached—the ether is forced through the filter and fills both limbs of the siphon, and then continues to flow automatically into a reservoir placed for its reception.

As the ethereal stratum diminishes, the tube carrying the funnel is depressed until its flat surface is within a line or so from the surface of the aqueous layer, and is engaged in the precipitate. When this occurs air has again to be blown through the small tube, and this is continued until drops of ether escape only at long intervals. The cork carrying the tubes is then removed, fresh ether poured into the bottle, agitated, and the series of operations described above again performed; and this may have to be repeated a third time.

When it is judged that the precipitate has been exhausted of principles soluble in ether the siphon is removed, and any particles adherent to the base or sides of the funnel brushed off, and the funnel with its attached filter-paper, as well as the exit end of the siphon, washed with a small quantity of ether or alcohol.

Obviously the apparatus may be used for all operations in which ether, &c., is used for the separation of alkaloids or fatty principles. By having a third aperture in the cork and fitting into it the delivery tube of a burette, the apparatus could be employed in certain volumetric analyses, the siphon-filter adding the part of a Beale's filter. Under such circumstances the tube carrying the funnel should be depressed until the mouth of the funnel is almost in contact with the bottom of the bottle, and the necessary agitation of the fluid, after addition of the precipitant, would then be effected by drawing air through it by the small bent tube.

In conclusion, I would wish it to be clearly understood that I do not claim originality for this little apparatus: it is merely an adaptation which I have found serviceable for a particular operation.

Medical College, Calcutta,
January 20th, 1882.

DETECTION OF TIN IN PRESENCE OF ANTIMONY.

By M. M. PATTISON MUIR, M.A.

THE test is founded on the fact that stannic chloride is reduced to stannous chloride by boiling with metallic copper.

The precipitated sulphides of the arsenic group are warmed with concentrated hydrochloric acid: the insoluble portion is washed and tested for arsenic by Bunsen's film test. The solution is somewhat diluted; about three-fourths of it is boiled for at least ten minutes with copper turnings (which must of course be free from tin), poured off from the copper, and tested for stannous chloride by adding mercuric chloride. The remaining smaller portion of the solution is poured on to a piece of platinum surrounded by a piece of zinc-foil. If the platinum become covered with a black deposit it is removed and examined in the ordinary way.

NOTE ON THE ACTION OF SULPHURIC ACID ON ZINC AND ON TIN.

By M. M. PATTISON MUIR, M.A., and C. E. ROBBS, B.A., B.Sc.

1. It was formerly noticed by one of us (see *Chem. Soc. Journ.*, 1880; *Trans.*, p. 427) that, when zinc is boiled with strong sulphuric acid, a point is reached at which evolution of gas slackens and sulphur begins to separate. A closer study of this reaction appeared likely to lead to results of some interest, and on those phenomena which are usually explained by the hypothesis of "nascent" hydrogen.

A complete investigation of the action of zinc on sulphuric acid would involve much labour and consume much time. The results which we have to offer, although only qualitative, are yet, we think, of some value, especially when considered in connection with those recorded in a paper on Nascent Hydrogen by Gladstone and Tribe (*Chem. Soc. Journ.*, 1879; *Trans.*, p. 172).

2. We have qualitatively examined the action of sulphuric acid of various degrees of concentration, and at various temperatures, on zinc and on tin. The formulæ given as representing the proportion of acid and water must be regarded as only approximately true. The specific gravity of "pure sulphuric acid" was determined by the hydrometer, and the quantity of water to be added calculated. "Pure granulated zinc" and "pure tin" cut, from sticks, into pieces as large as peas, were employed. Action proceeded in flasks connected with small bottles containing solution of lead acetate and an arrangement for drawing a current of air through the apparatus. Sulphur dioxide was tested for, partly by the smell and partly by passing the evolved gas into water and applying the ordinary tests to the liquid thus obtained. Of course very small traces of sulphur dioxide might escape detection, or small quantities might sometimes be actually formed, but be again decomposed by the sulphuretted hydrogen simultaneously evolved. The action was always stopped before the metal had completely dissolved.

The following tables contain the principal results:—

TABLE I.—ACTION OF SULPHURIC ACID ON ZINC.

| Approximate Concentration of Acid. | 4° to 5°. | Ordinary (20° to 25°). | 100°. | 130° to 140°. | 200° to 210°. |
|---|--|---|---|---|--|
| 7H ₂ SO ₄ : 2H ₂ O | | | | Very slight evolution of H: no H ₂ S nor SO ₂ . | *No H ₂ S; much SO ₂ , and slight precipitate of S. No H ₂ S: much SO ₂ and large precipitate of S. Much H ₂ S; no SO ₂ ; considerable precipitate of S. |
| 7H ₂ SO ₄ 4H ₂ O | | | | | |
| 7H ₂ SO ₄ : 6H ₂ O | | | | | |
| H ₂ SO ₄ : H ₂ O | | Very slight evolution of H. No H ₂ S nor SO ₂ . | A very little H ₂ S, accompanying H. | More H ₂ S. | Very large amount of H ₂ S; large precipitate of S. Nearly pure H ₂ S, with very little S. |
| H ₂ SO ₄ : 2H ₂ O | Very slight action: H only. | Minute traces of H ₂ S. | | | |
| H ₂ SO ₄ : 3H ₂ O | Very slight action: minute traces of H ₂ S, with H. | Decided traces of H ₂ S. | Considerable amount of H ₂ S. | H ₂ S in quantity. | At 160° acid boiled, much H ₂ S, and no S |
| H ₂ SO ₄ : 5H ₂ O | Traces of H ₂ S, with H. | H ₂ S traces; rather more than at 5°. | H ₂ S decided. | H ₂ S decided; more than at 100°. | } These at temperature of boiling acid. |
| H ₂ SO ₄ : 6H ₂ O | No H ₂ S: only H. | Only H. | Only H. | Very minute trace of H ₂ S. | |
| H ₂ SO ₄ : 7H ₂ O | Only H. | Only H. | Traces of H ₂ S. | Trace of H ₂ S; rather more than at 100°. | |

* No H₂S evolved at any temperature: SO₂ began to come off a little above 150°.

TABLE II.—ACTION OF SULPHURIC ACID ON TIN.

| | 20° to 25°. | 110° to 120°. | |
|---|--|--|-----------------------------------|
| 7H ₂ SO ₄ : 2H ₂ O | Very little action; no H ₂ S; slight precipitate of S; trace of SO ₂ . | Very slight trace of H ₂ S, large quantity of SO ₂ , and much S. | |
| H ₂ SO ₄ : H ₂ O | Trace of H ₂ S; very small precipitate of S. | A little H, decided H ₂ S, much SO ₂ , and a little S. | |
| H ₂ SO ₄ : 3H ₂ O | No action. | H ₂ S given off in quantity; SO ₂ absent or mere trace. No S. | |
| H ₂ SO ₄ : 5H ₂ O | No action. | H evolved, with trace of H ₂ S. | } These at temp. of boiling acid. |
| H ₂ SO ₄ : 7H ₂ O | No action. | Very slight action; a little H evolved. | |

3. When the conditions of our experiments agree with those of the experiments of Calvert and Johnson (*Chem. Soc. Journ.*, 19, 434), the general results also agree. These chemists carried out no experiments with tin at ordinary temperatures: in the action of zinc at ordinary temperatures they appear to have noticed the evolution of hydrogen only.

The tables show that strong sulphuric acid—(7H₂SO₄ : 2H₂O)—exerts no action on zinc until a high temperature is reached, and that the gaseous product of the action which then occurs is SO₂, accompanied by separation of a little sulphur; that the action of rather more dilute acid (7 : 4 mols.) is similar, but that more sulphur separates than with the stronger acid; that with an acid approximately of the strength 7H₂SO₄ : 6H₂O, sulphur dioxide is no longer produced, but only H₂S and sulphur; and that as the acid becomes more dilute action begins at lower temperatures with evolution of hydrogen only, or hydrogen with minute traces of H₂S, which last-named gas increases in quantity as temperature rises, but is not accompanied by sulphur or sulphur dioxide. Strong sulphuric acid begins to act on tin at ordinary temperatures, but the amount of action is very small: the gaseous product is SO₂, accompanied by a very slight separation of sulphur. As temperature rises, the quantities of both these substances increase and a little H₂S begins to appear. With a more dilute acid (1 : 1 mol.) H₂S comes off at a lower temperature, while at about 120° we have evolution

simultaneously of H, H₂S, and SO₂, and separation of S. More dilute acids have little or no action until the temperature approaches the boiling-point of the acids, when the gaseous products are hydrogen and sulphuretted hydrogen, or in the case of H₂SO₄ : 7H₂O hydrogen only, no sulphur being formed with these acids.

The general tendency is towards production of hydrogen and sulphuretted hydrogen when the amount of water present is considerable. As the water decreases the production of sulphuretted hydrogen increases, until a point is reached—approximately H₂SO₄ : H₂O—after which sulphur dioxide and sulphur are the chief (in the case of zinc the only) products.

The white solid substances produced in the flasks were collected in several cases, dried on a porous tile, and treated with dilute acid: in no case was a trace of sulphuretted hydrogen or sulphur dioxide produced. Therefore, we conclude that neither zinc nor tin sulphide is a product of the action under examination, and that therefore the production of sulphur, sulphur dioxide, or sulphuretted hydrogen is not to be traced to a secondary action between the acid and metallic sulphide produced in the primary change. In this respect the actions under consideration differ from that of sulphuric acid on copper (compare Pickering, *Chem. Soc. Journ.*, 1878; *Trans.*, p. 112, *et seq.*), and more nearly resemble that of nascent, or occluded, hydrogen on sulphuric acid (see Gladstone and Tribe, *loc. cit.*).

It seems very probable that the reduction of moderately

dilute sulphuric acid, with production of H_2S , noticed in these experiments, is to be traced to the action of nascent hydrogen, evolved by the primary action of the metal on the acid. But that the production of sulphur dioxide and sulphur from more concentrated acids is partly conditioned by the ease with which strong sulphuric acid undergoes dissociation, aided by the action of nascent hydrogen on the acid itself, and also on its dissociation products. The rapidity of evolution of the hydrogen must also influence the result; and that the nature of the metal used also modifies the action is shown by the fact that sulphur dioxide and sulphur are produced from the same acid at a much lower temperature by the action of tin than by the action of zinc.

ON
PEROXIDE OF HYDROGEN AS A MEANS FOR
BLEACHING, AND ITS
AVAILABILITY FOR TECHNICAL, MEDICINAL,
AND CHIRURGICAL PURPOSES.*

ACCORDING to the researches of Schœnbein ozonised oxygen is said to be the active principle in grass bleaching. Later and extremely exact researches by Emil Schœne have, however, proved, in conformity with the opinions of A. Houzeau and Fr. Goppelsrœder, that ozone is not engendered in the air during the process of bleaching, but rather, that all the reactions ascribed to the influence of ozone are due to the action of peroxide of hydrogen. Continued quantitative analyses to ascertain the air's titre of peroxide of hydrogen led to the perception that it depends in a great measure on external circumstances, such as the time of year and day, the movements of the air, &c., and Schœne is of opinion that the preponderating influence in its production must be ascribed to the light.

Atmospheric precipitations, particularly hoar-frost originating under certain conditions, contain considerable quantities of peroxide of hydrogen, namely 0.04 to 1 milligramme in one litre of liquid.

The quantities come to earth within 4 months amounted to 62.9 milligrams. per square metre.

Although "grass bleaching," bleaching with water, light and air, has been exercised with success for thousands of years, and though there was no lack of time and labour for the perfection of the process, yet there cannot be any misconception as to the fact that it is attended with considerable inconveniences. The result of grass bleaching can never be predicted with absolute certainty, especially within a fixed time. The usual way of bleaching mostly requires a great deal of time, and is attended, besides other drawbacks, with great loss of interest.

It will be sufficient to point to the extremely interesting operation of wax bleaching. There is lying at the wax bleachfields near Celle, material to the value of hundreds of thousands of marks, waiting for sunshine and wind. The consideration of these drawbacks will suffice to demonstrate how necessary it is to produce the bleaching medium of nature, the peroxide of hydrogen, in a concentrated form.

Chemistry has at its disposal a long series of combinations which contain oxygen only loosely bound, and which transfer it by their own decomposition to other bodies. These media of oxidation offer a base for the compensation of the oxygen of the air in bleaching, and the following are being technically used: nitric acid, nitrous acid, permanganic acid, chloric acid, chromic acid, and lastly the chloric gas in combination with bases, in the shape of bleaching salts. However manifold these bleaching

media may be, the use of all of them is attended with inconvenience, as they more or less injuriously affect the fibre to be bleached, and for this reason their application is limited and difficult. It is the peroxide of hydrogen alone which does not act in that way; it contains the effective agent operating in grass bleaching in a concentrated form, and is therefore superior to all other bleaching media, and in so far must be marked as the bleaching media of the future.

The peroxide of hydrogen was discovered in 1818 by Thénard, who obtained it by the action of acids on peroxide of barium in the presence of water. Thénard showed, that the oxygen of the peroxide of barium operated as an oxidiser on the water.



A great number of chemists afterwards occupied themselves with the peroxide of hydrogen; Pelouze, Duprey, Balard, J. Thomson, E. Schœne. All of them found the above way for its production the most preferable.

There always result solutions of a titre of only 5 per cent peroxide of hydrogen. The parting of the pure product H_2O_2 is proportionately difficult, on account of its great tendency to decompose. There are two ways for effecting concentration.

(1.) Freezing out. (2.) Evaporation in the vacuum over sulphuric acid at a temperature of 15° to 20° C. (59° to 68° F.)

The pure peroxide of hydrogen is a syrupy liquid of 1.453 sp. gr., which yields a 475-fold volume of oxygen in its decomposition. Diluted solutions equal solution of chlorine in their effect, and will keep for months in a temperature not exceeding 25° C. (77° F.) If protected from the influence of light. A trifling addition of acid has the effect of diminishing very considerably the tendency to decompose. On the other hand, alkalis and salts producing basic reaction hasten its decomposition.

This tendency of the peroxide of hydrogen to lose its oxygen places it amongst the media of oxidation. It is not in every case that the real reasons are known for the peroxide of hydrogen quickly surrendering its oxygen. There is a series of bodies which accelerate the evolution of oxygen, without themselves apparently undergoing a change. For instance all pointed, angular, sharp objects, precipitates, such as alumina and hydrated peroxide of iron, charcoal, then several metals when very finely grained, as silver, gold, platinum.

In a second series of cases the peroxide of hydrogen acts in the same way as any other medium of oxidation in yielding its oxygen to another body. In course of this process arsenious acid is oxidised to arsenic acid, sulphides are converted into sulphates.

Thirdly, peroxide of hydrogen can apparently act reductive, losing a portion of its oxygen in decomposing other oxidised bodies. In this manner it reduces the peroxides of lead and of manganese to oxide and protoxide.

In general it may be said, that the peroxide of hydrogen has a deoxidising action on acids which have an inclination to yield their oxygen (permanganic acid), oxidising on oxides in alkaline solution which have the opposite tendency.

Application of the Peroxide of Hydrogen for Technical
Purposes.

Almost every one who has treated of the subject of peroxide of hydrogen has predicated for it great future importance; the characteristic reactions almost obtrude themselves upon one's observation.

Dumas ("Handbook of Practical Chemistry," Nürnberg, 1830, vol. 1, page 119) had used it for cleaning discoloured oil paintings and valuable drawings. Starting, as he did, from the consideration that the fading of the paintings arose from the discolouration of the lights put on with white-lead, through the formation of sulphide of lead, and having regard to the regeneration of the latter

* A Lecture delivered by Dr. P. Ebell, Technical Director of the Chemical Works of E. de Haen at List near Hannover, at a meeting of the Branch Society of German Engineers at Hannover. From the *Industrie Blätter* of January 7th, 1882.

by the influence of peroxide of hydrogen into white sulphate of lead, success could not but follow the trials. —In spite of all that the peroxide was not made use of for a long time; it was only in 1870 that an intelligent perfumer employed it, making it an article of commerce in shape of a 3 per cent watery solution, as a means for bleaching the hair, and under various names as:—"Eau de fontaine de Jouvence, golden," "Golden hair water," "Auricome." About the same period prominent men drew attention to the faculty of reaction possessed by the peroxide of hydrogen as a recommendation for its use in medicine. A. v. Schrotter, R. Dettiger (*Annals of Chemistry*, 1873, p. 365), then Geiger ("Handbook of Pharmacy," 1, page 213, 4th edit.). Hager also states methods for its production in his "Pharmaceutical Practice."

If in spite of all this peroxide of hydrogen played only a subordinate part, especially in medicine, the reasons are to be found on the one hand in the slighting treatment which was accorded to it by practical chemistry, on the other in its own most valuable and specific peculiarities, which in certain directions were antagonistic, and which to superficial observation seem still inimical to its being taken into general use.

In the first place the production of the peroxide of hydrogen, so far as regards quantities and purity of the article, was until lately an unsolved problem.

What practical chemistry could offer were only solutions charged with impurities in the shape of various salts and acids, and of the most uncertain and varying composition. For this reason alone uniform, thorough success in any direction could not be attained. But besides that the price could not be but enormous in consequence of the disability to fully exhaust the materials used in its manufacture, and an entire want of demand for the article. These drawbacks are now overcome, and peroxide of hydrogen can be had in watery solution with a titre of 3 per cent by weight, or of 10 volumes, in a uniform, chemically pure state at low prices and in large quantities.

The doubts with regard to durability and to transport to distant parts may be considered as solved.

The watery solution corresponds in its conditions to solution of chlorine; when light is excluded, and temperature does not exceed 25° C. (77° F.), it loses only a trifling amount of its entire titre of peroxide of hydrogen, and therefore the "Peroxide of hydrogen question" must be considered answered with regard to its first part, comprising its chemical production and its capacity of undergoing unharmed the difficulties of transport.

With regard to the second part, its "technical use," the following remarks, which are based on our own practical observation, are destined to serve as "directions."

Peroxide of Hydrogen as Bleaching Material for Products of Animal Origin.

All products, which are to be subjected to a bleaching process by peroxide of hydrogen must be submitted to a preparatory treatment, the purpose of which is to render them capable in every part of being moistened by a watery solution of the peroxide of hydrogen. Every particle of fat, sweat, and impurity adhering to the objects to be bleached must be taken away.

Besides bathing in a solution of good soap, solutions of 3 to 5 per cent of carbonate of ammonia have in the first place shown themselves of value; in various cases new means of solution, such as sulphide of carbon, benzene, ether, &c., have been found available.

With regard to the process of bleaching itself, two different principles can be brought into operation.

The watery solution of 10 volume peroxide of hydrogen is neutralised as far as possible by some drops of liquid ammonia and then used directly as a bleaching bath.

For a continued process of bleaching it is advisable to use a series of baths, through all of which the object to be bleached passes systematically, commencing

with the weakest. Light must be excluded, and temperature not be allowed to exceed 25° C. (77° F.).

The second method is based on the same principle, but carried out in a different way.

The objects preliminarily prepared as above stated are steeped in the solution of peroxide of hydrogen. After being fully impregnated with the liquor, they are taken out and subjected to a process of drying in a current of air, which must not exceed a temperature of 20° C. (68° F.).

The process of bleaching progresses energetically during the evaporation of the water, and the concentration of the solution of peroxide of hydrogen occasioned thereby.

It is a matter of calculation, or depends upon other circumstances, whether the one or the other proceeding is to be carried through.

Bleaching of Hair with 3 per cent Solution of Peroxide of Hydrogen.

The hair was digested for 12 hours in a solution of 3 parts carbonate of ammonia in 100 parts of water at a temperature of 30° C. (86° F.), rinsed, then washed with soap, and all the fatty matter removed with the help of a fresh solution of carbonate of ammonia. Benzene can also be recommended. Prepared in this way, it was immersed in a bath of peroxide of hydrogen, fully neutralised with liquid ammonia.

It remained either in the bath until sufficiently bleached, or was dried in a room at ordinary temperature, and the immersion repeated.

The baths must only be considered fully exhausted, when some drops of permanganate of potash produce in the liquor a permanent red colouration.

It has not been found feasible to bleach black hair so that it becomes perfectly white, its colour only disappearing so far as to arrive at a light golden fair hue. Even a jet black Chinese tail did not resist.

The bleaching of hair even on living persons does not present any difficulties. After the desired degree of bleaching has been arrived at, an after treatment by washing with water, followed by a wash with alcohol, takes place; hot liquids or drying in drying chambers are excluded.

Bleaching of Feathers, especially Ostrich Feathers with Peroxide of Hydrogen.

As a means of bleaching feathers, the peroxide of hydrogen is far superior to all other substances proposed for the same purpose, and has proved itself of value in every way, especially for ostrich feathers.

Its superiority rests especially on the oxidation and thorough removal of colouring matter, without the slightest detriment to the structure of the feather itself.

By way of preparation the feathers are placed in a bath of carbonate of ammonium containing 1 to 2 parts of salt in 100 parts of water, where they are left for 12 hours at a temperature of 20° C. (68° F.), being gently moved about in the bath the while.

After this they are being steeped and moved about in a luke-warm bath of Marseilles soap, and at last well rinsed with water exempt from lime. Boiling or hot liquids must be excluded.

Treatment with pure benzene and ether has also shown very good results.

For feathers it is only admissible to bleach in baths, which must be made neutral, and not be prepared and kept in metal or wood vessels. Earthenware, or stone-ware vessels are the best adapted for the purpose.

In cases where the feathers are for a long time exposed to the influence of slightly acidulated liquid, there occur, as with all other organic matter, appearances of wasting away in the liquid; they begin to show signs of decay, and lose their beauty to a great degree.

The bleaching finished, the feathers are slowly dried in a low temperature and in moving air, while being repeatedly beaten. At higher temperature the formation of gluey matter easily takes place, in consequence whereof

the finest fibrils stick together; beating acts as a preventive to that drawback.

It has formerly been proposed to dust the feathers while still in a damp state with hair powder, and then only to dry them.

The powder acts on the feathers in a similar way as do tanning materials in tanning; like these it prevents the tendency to flake.

Very favourable results may be attained by steeping the bleached and still wet feathers in alcohol; this makes the gluey insoluble formations settle down, and the liquid evaporating at very low temperature, it leaves the feathers of woolly and beautiful appearance. By steeping the feathers in benzene, and allowing it to evaporate, the same end is gained with even better results.

The further treatment of the feathers, as scraping, trimming, and curling, can be only mentioned here in passing.

The success of the bleaching of feathers in the above manner is thorough in comparison with other proceedings.

Even entirely black spots are bleached after continued action of the bath.

Bleaching of Silk with Peroxide of Hydrogen.

For bleaching silk a whole series of strong oxidisers, as permanganic acid, chromic acid, nitric acid, have been proposed, and besides them sulphurous acid has been used to advantage. As is the case with bees'-wax, the colouring matters of raw silk are capable of resisting bleaching materials in different degrees; some sorts of silk are easily susceptible to their influence, while others resist it strongly.

Amongst the latter is the product of the wild silkworm, the so-called Tussah silk, a fine and durable thread of strongly pronounced brown colour.

According to our trials, peroxide of hydrogen is the best means of bleaching this silk, the objectionable brown colour being reduced by its action to a but little distinguishable, pleasing yellow. After the boiling of the gum by subjecting the raw silk to a treatment with soap baths of various strengths, and final boiling in concentrated solutions of soap, it is recommended to treat it with carbonate of ammonia.

After that, the scoured silk must be subjected to the action of peroxide of hydrogen, in the same way as mentioned under the heading of "bleaching of hair."

Alcohol, eventually mixed with a little glycerin, has in this case also shown itself of value for an after-treatment.

Bleaching of Ivory and Bone.

Records as to the bleaching of bony substances and ivory are very scarce.

Almost universally the process of bleaching in sunlight by means of air and water, which is very trying to the bone, is being had recourse to; for ivory chloride of lime has been proposed.

The outward layers of the bone are constant; they encircle the inner membrane enclosing the marrow, being themselves covered by their skin.

Besides organic substances, such as fat and cartilage or gelatinous substance, they contain 70 to 80 per cent of phosphate of lime, carbonate of lime, and fluoride of calcium.

The purpose of the preparation of the bone is, as in the case of all the other substances heretofore mentioned, the removal of fatty matter. While formerly they were treated with steam under pressure, and the fat skimmed off, there have lately been patents taken out for using solvents, such as sulphide of carbon, ether, benzene, and it is said that their use offers advantages as compared with the former way of proceeding, not only with regard to quality and quantity of fatty matter, but also in consequence of the loss of gelatinous substances being only trifling.

Lyes of carbonates of alkalis must be more or less excluded for the above purpose, but weak solutions of carbonate of ammonia may be used.

The bones freed from fatty matter are immersed—preferably while in a primary state of manufacture—an almost neutral solution of peroxide of hydrogen, and left in this bath as long as may be requisite. The process of bleaching takes place smoothly and safely; even spots where remainders of blood have been left behind in the pores in a dried state acquire a perfectly white appearance.

Ivory is treated in exactly the same way as bones; fans, handles of walking sticks, and knife handles, bleached by peroxide of hydrogen are already being used very extensively.

The methods, according to which it is feasible to use the peroxide of hydrogen as a means for bleaching in various ways, and in a practical manner, have been treated of in the foregoing in a general way; by following them, products of considerably higher value will be obtained than was possible by adhering to former practices.

It will, however, be the task of those interested in the use of the peroxide of hydrogen to further develop the process of bleaching in special cases, and to adapt it to their particular requirements.

Application of Peroxide of Hydrogen for Medicinal Purposes.

The peroxide of hydrogen has not hitherto played a conspicuous part in therapeutics. The reason for that may be, that formerly pure and durable solutions were not to be had at a reasonable figure. Price, however, is no longer an impediment to its use, and the tendency of the peroxide of hydrogen as at present obtainable to decompose, can be considerably restricted; possibly peroxide of hydrogen turned into simple water may formerly have led to wrong conclusions. Peroxide of hydrogen if preserved in the dark, and in a temperature not exceeding 25° C. (77° F.), keeps unaltered for months. For ascertaining its titre of active oxygen a normal solution of permanganate of potash is requisite; it would be advisable to fix a minimum titre of active oxygen. It is to be supposed that peroxide of hydrogen, like chloride, bromide, and permanganate of potash, is poison to the smallest organisms (bacteria); exact comparative experiments with a view to ascertain this are much to be desired, considering the importance of the matter. Experiments with yeast instituted by the lecturer had very favourable results, and proved that the germs of the yeast are entirely killed by peroxide of hydrogen, even when greatly diluted.

As regards the fitness of peroxide of hydrogen, for treating wounds, caused by syphilitic, scrophulous, and tuberculous ulcers, favourable experience has been gleaned by a physician at Hanover. It is probable that peroxide of hydrogen will do good service in the shape of spray in making operations and ligatures; this would be important, considering the effect which carbolic acid spray often has on operators and patients.

The great advantages possessed by peroxide of hydrogen, as compared with other media of disinfection, are:—

(1) Complete want of smell.
(2) Yielding oxygen without leaving any other residuum but pure water.

(3) Absence of injurious influence on the organism.

The workmen occupied in making the peroxide of hydrogen get exceedingly delicate hands, and wounds heal visibly under its influence.

There further seems room for employing the peroxide of hydrogen as a means of disinfecting sick chambers and generally for purifying the air. It would be advisable to spread by means of a rafrachisseur spray of diluted peroxide of hydrogen by way of trial.

Attention must also be drawn to the use of peroxide of hydrogen in dentistry, as has in the first place been done by C. Sauer (*Quarterly Review of Dentistry*, 1870, No. IV.). Sauer made use of the peroxide of hydrogen with success in bleaching discoloured and carious teeth. In cases where the teeth are covered with coloured matter (*Lichen dentalis* &c.) he employs peroxide of hydrogen in conjunction with

finely levigated pumice stone as a means of cleaning, in place of water. Teeth, the native channels of which were filled with coloured matter, became somewhat paler after several applications. A suitable liquid for cleaning teeth and mouth is prepared by mixing 1 part of 3 per cent peroxide of hydrogen with 10 parts of water. In case of carious teeth the peroxide of hydrogen on wadding was locally used with advantage.

CELESTIAL CHEMISTRY FROM THE TIME OF NEWTON.*

By T. STERRY HUNT, LL.D., F.R.S.

THE late W. Vernon Harcourt, in 1845,† called attention to the remarkable perception of great chemical truths which is apparent in the Queries appended to the third book of Newton's "Optics," as well as in his Hypothesis touching Light and Colour. With regard to the latter, Harcourt then remarked, "It has, I think, scarcely been quoted, except by Dr. Young, and its existence is but little known, even among the best-informed scientific men." The essay in question was read before the Royal Society, December 9th and 16th, 1675, but remained unpublished till 1757, when Birch, at that time Secretary to the Society, printed it, not without verbal inaccuracies, in the third volume of his "History of the Royal Society"—a work intended to serve as Supplement to the *Philosophical Transactions* up to that date. In 1846, at the suggestion of Harcourt, the Hypothesis of Newton was again printed in the *L. E. and D. Philosophical Magazine* (vol. xxix.), and it subsequently appeared in the Appendix to the first volume of Brewster's "Memoirs of Sir Isaac Newton," in 1855.

The time has come for further inquiries into the science of Newton, and I shall endeavour to show that a careful examination of the writings of our great natural philosopher, in the light of the scientific progress of the last generation, renders still more evident the wonderful prevision of him who already, two centuries since, had anticipated most of the recent speculations and conclusions regarding cosmic chemistry.

As an introduction to the inquiries before us, and in order to show the real significance of the speculations of Newton, it will be necessary to review, somewhat at length, the history of certain views enunciated almost simultaneously by the late Sir Benjamin Brodie, of Oxford, and the present writer, and subsequently developed and extended by the latter. In Part I. of his "Calculus of Chemical Operations," read before the Royal Society, May 3, 1866, and published in the *Philosophical Transactions* for that year, Brodie was led to assume the existence of certain ideal elements. These, he said, "though now revealed to us through the numerical properties of chemical equations only as *implicit and dependent existences*, we cannot but surmise may sometimes become, or may in the past have been, *isolated and independent existences*." Shortly after this publication, in the spring of 1867, I spent several days in Paris with the late Henri Sainte-Claire Deville, repeating with him some of his remarkable experiments in chemical dissociation, the theory of which we then discussed in its relations to Faye's solar hypothesis. From Paris, in the month of May, I went, as the guest of Brodie, for a few days to Oxford, where I read for the first time and discussed with him his essay on the "Calculus of Chemical Operations," in which connection occurred the very natural suggestion that his ideal elements might perhaps be liberated in solar fires, and thus be made evident to the spectroscopist. I was then about to give, by invitation, a lecture before the Royal Institution on "The Chemistry

of the Primeval Earth, which was delivered May 31, 1867. A stenographic report of the lecture, revised by the author, was published in the *CHEMICAL NEWS* of June 21, 1867, and in the *Proceedings of the Royal Institution*. Therein I considered the chemistry of nebulae, sun, and stars in the combined light of spectroscopic analysis and Deville's researches on dissociation, and concluded with the generalisation that the "breaking-up" of compounds, or dissociation of elements, by intense heat, is a principle of universal application, so that we may suppose that all the elements which make up the sun, or our planet, would, when so intensely heated as to be in the gaseous condition which all matter is capable of assuming, remain uncombined,—that is to say, would exist together in the state of chemical elements,—whose further dissociation in stellar or nebulous masses may even give us evidence of matter still more elemental than that revealed in the experiments of the laboratory, where we can only conjecture the compound nature of many of the so-called elementary substances."

The importance of this conception, in view of subsequent discoveries in spectroscopy and in stellar chemistry, has been well set forth by Lockyer in his late lectures on Solar Physics,* where, however, the generalisation is described as having been first made by Brodie in 1867. A similar but later enunciation of the same idea by Clerk-Maxwell is also cited by Lockyer. Brodie, in fact, on the 6th of June, one week after my own lecture, gave a lecture on Ideal Chemistry before the Chemical Society of London, published in the *CHEMICAL NEWS* of June 14th, in which, with regard to his ideal elements, in further extension of the suggestion already put forth by him in the extract above given from his paper of May 6, 1866, he says "We may conceive that in remote ages the temperature of matter was much higher than it is now, and that these other things [the ideal elements] existed in the state of perfect gases—separate existences—uncombined." He further suggested, from spectroscopic evidence, that it is probable that "we may one day, from this source, have revealed to us independent evidence of the existence of these ideal elements in the sun and stars."

During the months of June and July, 1867, I was absent on the Continent, and this lecture of Brodie's remained wholly unknown to me until its republication in 1880, in a separate form, by its author,† with a preface, in which he pointed out that he had therein suggested the probable liberation of his ideal elements in the sun, referring at the same time to his paper of 1866, from which we have already quoted the only expression bearing on the possible independence of these ideal elements somewhere in time or in space.

The above statements are necessary in order to explain why it is that I have made no reference to Sir Benjamin Brodie on the several occasions on which, in the interval between 1867 and the present time, I have reiterated and enforced my views on the great significance of the hypothesis of celestial dissociation as giving rise to forms of matter more elemental than any known to us in terrestrial chemistry. The conception, as at first enunciated in somewhat different forms alike by Brodie and myself, was one to which we were both naturally, one might say inevitably, led by different paths from our respective fields of speculation, and which each might accept as in the highest degree probable, and make, as it were, his own. I write, therefore, in no spirit of invidious rivalry with my honoured and lamented friend, but simply to clear myself from the charge, which might otherwise be brought against me, of having, on various occasions within the past fourteen years, put forth and enlarged upon this conception without mentioning Sir Benjamin Brodie, whose only publication on the subject, so far as I am aware, was his lecture of 1867, unknown to me until its reprint in 1880.

It was at the grave of Priestley, in 1874, that I for the second time considered the doctrine of celestial dissociation.

* Read before the Cambridge Philosophical Society, November 28, 1861, and reprinted from its *Proceedings*.

† *L. E. and D. Phil. Mag.*, III., xxviii., 106 and 478; also xxix., 185.

* *Nature*, August 25, 1881, vol. xiv., p. 396.

† *Ideal Chemistry, a Lecture*, Macmillan, 1880.

tion, commencing with an account of the hypothesis put forward by F. W. Clarke, of Cincinnati, in January, 1873,* to explain the growing complexity which is observed when we compare the spectra of the white, yellow, and red stars; in which he saw evidence of a progressive evolution of chemical species, by a stoichiogenic process, from more elemental forms of matter. I then referred to the further development of this view by Lockyer, in his communication to the French Academy of Sciences, in November of the same year, wherein he connected the successive appearance in celestial bodies of chemical species of higher and higher vapour-densities with the speculations of Dumas and Pettenkofer as to the composite nature of the chemical elements.† I then quoted from my lecture of 1867 the language already cited, to the effect that dissociation by intense heat in stellar worlds might give us more elemental forms of matter than any known on earth, and further suggested that the green line in the spectrum of the solar corona, which had been supposed to indicate a hitherto unknown substance, may be due to a "more elemental form of matter, which, though not seen in the nebulae, is liberated by the intense heat of the solar sphere, and may possibly correspond to the primary matter conjectured by Dumas, having an equivalent weight one-fourth that of hydrogen." The suggestion of Lavoisier, that "hydrogen, nitrogen, and oxygen, with heat and light, might be regarded as simpler forms of matter from which all others are derived," was also noticed in connection with the fact that the nebulae, which we conceive to be condensing into suns and planets, have hitherto shown evidences only of the presence of the first two of these elements, which, as is well known, make up a large part of the gaseous envelope of our planet, in the forms of air and aqueous vapour. With this I connected the hypothesis that our atmosphere and ocean are but portions of the universal medium which, in an attenuated form, fills the interstellar spaces; and further suggested, as "a legitimate and plausible speculation," that "these same nebulae and their resulting worlds may be evolved by a process of chemical condensation from this universal atmosphere, to which they would sustain a relation somewhat analogous to that of clouds and rain to the aqueous vapour around us."

These views were reiterated in the preface to a second edition of my "Chemical and Geological Essays," in 1878; and again before the British Association for the Advancement of Science, at Dublin,‡ and before the French Academy of Sciences in the same year.§ They were still further developed in an essay on the "Chemical and Geological Relations of the Atmosphere" (published in the *American Journal of Science* for May, 1880), in which attention was called to the important contribution to the subject by Mr. Lockyer in his ingenious and beautiful spectroscopic studies, the results of which are embodied in his "Discussion of the Working Hypothesis that the so-called Elements are Compound Bodies," communicated to the Royal Society, December 12, 1878. It was then remarked that the already noticed "speculation of Lavoisier is really an anticipation of that view to which spectroscopic study has led the chemists of to-day;" while it was said that the hypothesis put forth by the writer in 1874, "which seeks for a source of the nebulous matter itself, is perhaps a legitimate extension of the nebular hypothesis."

To show the connection of the above views with the philosophy of Newton, it now becomes necessary to give some account of the conception of the universal distribution of matter throughout space, both as regards its dynamical relations and its chemical composition. Passing

over the speculations of the Greek physiologists, we come to the controversies on this subject in the seventeenth century, and find, in apparent opposition to the plenum maintained by Descartes and his followers, the teaching of Newton that "the heavens are void of all sensible matter." This statement is, however, qualified elsewhere by his assertion, that "to make way for the regular and lasting movements of the planets and comets, it is necessary to empty the heavens of all matter, except perhaps some very thin vapours, steams, and effluvia arising from the atmospheres of the earth, planets, and comets, and from such an exceedingly rare ethereal medium as we have elsewhere described," &c. ("Optics," Book III., Query 28).

In order to understand fully the views of Newton on this subject, it is necessary to compare carefully his various utterances, including the Hypothesis, in 1675, the first edition of the "Principia," in 1687, the second edition, in 1713, and the various editions of the "Optics." This work appeared in 1704, the third book, with its appended queries, having, according to its author's preface, been "put together out of scattered papers" subsequent to the publication of the first edition of the "Principia." The Latin translation of the "Optics," by Dr. Clarke, which was published in 1706, and the second English edition, in 1718, contain successive additions to these queries, which are indicated in the notes to Horsley's edition of the works of Newton, and are important in this connection. From a collation of all these we learn how the conceptions of the Hypothesis took shape, were reinforced, and in great part incorporated in the "Principia."

In the Hypothesis he imagines "an ethereal medium much of the same constitution with air, but far rarer, subtler, and more elastic." "But it is not to be supposed that this medium is one uniform matter, but composed partly of the main phlegmatic body of ether, partly of other various ethereal spirits, much after the manner that air is compounded of the phlegmatic body of air intermixed with various vapours and exhalations." Newton further suggests in his Hypothesis that this "complex spirit or ether, which, by its elasticity, is extended throughout all space, is in continual movement and interchange." "For Nature is a perpetual circulatory worker, generating fluids out of solids, and solids out of fluids, fixed things out of volatile, and volatile out of fixed, subtle out of gross, and gross out of subtle; some things to ascend and make the upper terrestrial juices, rivers, and the atmosphere, and by consequence others, to descend for a requital to the former. And as the earth, so perhaps may the sun imbibe this spirit copiously, to conserve his shining, and keep the planets from receding farther from him; and they that will may also suppose that this spirit affords or carries with it thither the solar fuel and material principle of life, and that the vast ethereal spaces between us and the stars are for a sufficient repository for this food of the sun and planets."

The language of this last sentence, in which his late biographer, Sir David Brewster, regards Newton as "amusing himself with the extravagance of his speculations," at which "we may be allowed to smile," was not apparently regarded as unreasonable by its author when, more than ten years later, he quoted it in the postscript of his letter to Halley, dated Cambridge, June 20, 1686. The views therein contained, with the single exception of the suggestion regarding gravitation, have not wanted advocates in our own time, and many of them were embodied in the "Principia," which Newton was then engaged in writing.

But this was not all: Newton saw in the cosmic circulation, and the mutual convertibility of rare and dense forms of matter, a universal law, and rising to a still bolder conception, which completes his Hypothesis of the Universe, adds: "Perhaps the whole frame of Nature may be nothing but various contextures of some certain ethereal spirits or vapours, condensed, as it were, by precipitation,

* Brewster's "Memoirs of Newton," vol. I. pp. 121 and 404.

* Clarke, "Evolution and the Spectroscope," *Popular Science Monthly*, New York, vol. 12, p. 32.

† Lockyer, *Comptes Rendus*, November 3, 1873.

‡ A Century's Progress in Theoretical Chemistry; being an Address at Northumberland, Penn., July 31, 1874. *Amer. Chemist*, vol. 7, pp. 46-51, and *Popular Science Monthly*, vii, p. 420.

§ *Nature*, August 29, 1878, vol. xviii, p. 472.

§ *Comptes Rendus*, Sept. 23, 1876, vol. xxviii, p. 432.

much after the same manner that vapours are condensed into water, or exhalations into gaseous substances, though not so easily condensable; and after condensation wrought into various forms, at first by the immediate hand of the Creator, and ever since by the power of Nature, which, by virtue of the command 'Increase and multiply,' became a complete imitator of the copy set her by the great Protoplast. Thus, perhaps, may all things be originated from ether."

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Annual General Meeting, Saturday, February 11th, 1882.

Prof. W. GRYLLS ADAMS in the Chair.

THE PRESIDENT read the Report of the Council for the past year, from which it appeared that in this, the tenth year of the Society, it was in a highly satisfactory condition and numbered 331 members. Sir Charles Wheatstone's papers had been published, Dr. Joule's were soon to be so, and delegates from the Society had taken part in the Electrical Congress at Paris, the Lightning Rod Committee, &c.

THE TREASURER (Dr. Atkinson) read the Audited Report of the financial state of the Society: and the following officers were, after a ballot, declared elected for the ensuing year:—

President—Prof. R. B. Clifton, F.R.S.

Vice-Presidents—Sir W. Thomson (past President), Prof. G. C. Foster, Prof. F. Fuller, Dr. J. Hopkinson, Lord Rayleigh.

Secretaries—Prof. A. W. Reinold, Prof. W. Chandler Roberts.

Treasurer—Dr. E. Atkinson.

Demonstrator—Prof. F. Guthrie.

Other Members of Council—Prof. W. G. Adams, Prof. W. E. Ayrton, Mr. Shellford Bidwell, Mr. Walter Baily, Prof. J. A. Fleming, Mr. R. J. Lecky, Dr. Hugo Müller, Prof. Osborne Reynolds, Prof. A. W. Rüchler.

Honorary Member—Prof. G. Quincke.

Votes of thanks were then passed to the Lords Commissioners of the Committee of Council on Education for the use of the Meeting Hall, to the past President (Sir W. Thomson), to the Secretaries, the Treasurer, and Demonstrator, as well as to the Auditors, Mr. Shellford Bidwell and Mr. E. Rigg.

Prof. ADAMS then resolved the meeting into an ordinary one, and called Prof. Clifton to the Chair.

Dr. C. R. ALDER WRIGHT, F.R.S., then read a paper "On the Relation between the Electromotive Force of a Daniel Element and the Chemical Affinity involved in its Action." The author has investigated the causes which lead to a fall of E.M.F. in a Daniell cell when in action. He found the amount of fall for increasing current densities and plotted it in a curve. The fall was slight when pure commercial or amalgamated zinc, or zinc coated with a film of copper, was employed. Amalgamated copper plate gave more rapid rates of fall than electro-coated ones. Dilute sulphuric acid round the zinc gave a less rapid fall than sulphate of zinc solution round it. In all cases no appreciable fall was noticed when the current did not exceed 8 micro-Amperes per square centimetre of plate surface. With four to six times this density a decrease of E.M.F. from 0.5 to 1 per cent resulted; and with currents exceeding 3000 micro-Amperes in density per square centimetre of surface the fall exceeded 10 per cent. A series of experiments were made to determine the fall due to change in the density of the solution by migration of the ions, causing a stronger zinc

and a weaker copper solution. This showed that with nearly saturated zinc sulphate solution (sp. gr. 1.14) and very dilute copper sulphate solution, the maximum fall in E.M.F. is developed, and is less than 0.04 volt. Hence the total fall in E.M.F. due to migration of the ions when moderately strong currents pass, is only a fraction of the total fall. It follows that the energy due to the actions taking place in the cell, although wholly manifested as electric action expressible in Volt-Coulombs when the current is very small, is not wholly so manifested when the current is stronger. The author expresses this idea by calling the energy manifested in electric action *adjuvant* and the remainder as *non-adjuvant*. He finds that the major part of the latter energy is absorbed in actions having their seat at the surface of the copper plate, and the rest in actions at the surface of the zinc plate. It is transformed into heat according to Joule's law. As a subsidiary result it appears that the E.M.F. of a Daniell cell with zinc and copper sulphate solutions of equal specific gravity, or pure amalgamated zinc plate, and either a freshly deposited copper or an amalgamated copper plate, is a standard subject to less departure from the E.M.F. of other Daniell cells than the Clark's standard elements, which appear to vary one from another. On the other hand, a Clark cell keeps sensibly constant to its original value (if properly set up) during a period of months or years at a constant temperature, whereas a Daniell standard falls from its original value after a few hours, or days at most.

NOTICES OF BOOKS.

The Practice of Commercial Organic Analysis. By ALFRED H. ALLEN, F.I.C., F.C.S., Lecturer on Chemistry at the Sheffield School of Medicine, &c. Volume II., Hydrocarbons; Fixed Oils and Fats; Sugars; Starch and its Isomers; Alkaloids and Organic Bases, &c. London: J. and A. Churchill.

MANY of our readers will be glad to hear of the appearance of this long-promised volume. The first part of Mr. Allen's work so clearly supplied a want, that the necessity for a book treating of previously-omitted portions of the subject has been the more felt. The volume just published is half as large again as Volume I., and is based on a similar plan. In his preface the author expresses regret that the growth of the subject-matter has compelled him to omit several important sections, but a feeling that it was better to ignore a subject entirely than to treat it inadequately had caused him to postpone their consideration till a demand should arise for an additional volume or a second edition of those already published. On the subjects treated in the volume under review Mr. Allen writes fully and in many cases exhaustively, though it is only to be expected that in a book dealing with such a variety of material those sections should be most elaborate which treat of bodies in the examination of which the author has had special experience.

In the chapter on "Hydrocarbons" the author gives a useful table showing the various organic products respectively obtained by the distillation of coal, bituminous shale, peat, wood, and petroleum. Full details are given of the methods of assaying petroleum and shale products, including lubricating oils, vaseline, and paraffin wax. Turpentine, essential oils, and rosin oil are described in the section on "Terpenes," and then follow valuable and suggestive sections on "Benzene and its Homologues," "Naphthalene," and "Anthracene." The descriptions of the methods of assaying commercial benzols and coal-tar naphthas, and of examining crude anthracene deserve special mention, as they are by far the most complete account yet published, and ought to render the book indispensable to tar distillers and managers of gas works.

The next division of the volume is devoted to "Fixed Oils and Fats;" but fatty acids, bees'-wax, spermaceti, and soaps receive full descriptions in sections under the same general head. The chapter on "Fixed Oils and Fats" occupies 140 pages of the volume, and in our opinion is likely to be one of the most widely appreciated portions of the work. It forms a valuable addition to a much neglected and difficult branch of applied chemistry, and will be useful even if regarded merely as a carefully compiled *resumé* of isolated observations and tests. Under certain heads, however,—as, for example, "Sperm Oil," "Hydrocarbon Oils in Fixed Oils," and the "Temperature-reactions of Oils,"—the author adds to the general value of the chapter by the results of personal observations.

In the next division Mr. Allen gives an account of the optical assay of sugars, sections on the density of saccharine liquids, and the assay of cane-sugar, commercial glucose, malt, honey, and other products.

The chapter on "Starch and its Isomers" perhaps contains less of novelty than the other divisions of the work, but will be valuable for the tabulated scheme for the proximate analysis of plant products, which has been compiled from the directions of Prescott. Full directions are also given for the detection of adulterations of flour and bread.

The concluding chapter is devoted to the consideration of the "Alkaloids and Organic Bases," which are arranged under seven heads. The section dealing with Cinchona Alkaloids is one of the most complete descriptions of these bases in the English language, and the Opium Alkaloids are also fully treated. The reactions of and methods of isolating strychnine are detailed at length, but the less important vegetable alkaloids receive in many cases a very meagre description. Full directions are given for the assay of aniline oils, and there is an interesting and concise description of the leading basic derivatives of aniline. Instructions are also given for the examination of the leading aniline dyes for adulterants, and for the recognition of various dyes on tissues.

Although the volume is open to the charge of being somewhat unequally written, it is, on the whole, a valuable contribution to chemical literature. It is certainly calculated to increase the reputation of the author, and is an indispensable addition to the library of all who require to examine any of the numerous products of which the author treats.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 3, January 16, 1882.

Speed of Propagation of Explosive Phenomena in Gases.—MM. Berthelot and Vieille.—The general mean speed of propagation in a tube, whether curved or straight, 0.005 metre in diameter, is 2810 metres per second. The material of the tube is indifferent. The speed is sensibly the same whether the tube is open or closed. The differences observed in tubes of different lengths fall within the limits of error. Under the circumstances of the authors' experiments the speed of propagation of detonation, either with a mixture of oxygen and hydrogen, or of oxygen and carbon oxide, is independent of the degree of pressure. The introduction of an inert gas retards the detonation.

Chemical Studies on the Skeleton of Plants. Part Second: Vasculose.—MM. E. Frey and Urbain.—Vasculose is insoluble in all neutral solvents. It is unaffected by boiling in dilute sulphuric, hydrochloric, and phosphoric acids. It resists the action of trihydrated

sulphuric acid and of boiling alkaline solutions. Concentrated sulphuric acid acts upon it slowly, dehydrating it and changing its colour. Vasculose is rapidly attacked by all oxidising agents such as nitric acid, chromic acid, permanganates, chlorine, the hypochlorites, bromine, &c., producing a series of resins. Those first formed are not sensibly soluble in alcohol; those afterwards formed dissolve both in alcohol and ether. In decaying wood the normal proportion of vasculose is much reduced, as it has been converted by the gradual action of the atmosphere into resins, such as those above mentioned, which are dissolved away by alkalis and ammonia. The formula assigned to vasculose is $C_{56}H_{72}O_{16}$.

Influence of the Form of Polar Surfaces upon the Explosive Potential.—J. B. Baillie.—For a given explosive length the potential is at its maximum when the spark plays between two spheres of the same diameter. It deviates so much the more from the maximum as the difference of the curvature of the poles is greater and as the potential is higher.

Essence of Savory (*Satureia montana*).—A. Haller.—The author expected to find in this essence a camphor, of which, however, it does not contain a trace, being a mixture of hydrocarbons and phenols. Carvacrol is present to the extent of 35 to 40 per cent. The carbides appear to be terpenes.

A Diatomic Alcohol derived from β -Naphthol.—G. Rousseau.—The alcohol in question is a white crystalline powder, which melts with decomposition at 230°. Its composition is represented by $C_{22}H_{12}O_2$. It is insoluble in alkalies. If heated in the water-bath with sulphuric acid it dissolves to a blood-red liquid, having a splendid green fluorescence.

Phosphoric Acid in the Arable Soils of the North of France.—A. Ladureau.—The author shows by observation and analysis that the opinion entertained of the utility of phosphatic manures is unfounded.

Justus Liebig's Annalen der Chemie,
Band 210, Heft 2 and 3.

Researches from the Chemical Institute of the University of Strasbourg.—These consist of a memoir by Siegmund Levy and Gustav Schultz, on the chlorine and bromine derivatives of quinoxin; a paper on the action of ammonia and amine-bases upon chlorinated quinoxins, by H. v. Knapp and G. Schultz; and researches on a new mode of formation of diphenylene, and on a new isomer of this compound, by H. Straube and G. Schultz.

Determination of the Chemical Affinity of the Metals for Oxygen according to the Heats of Combination, as compared with the Determinations according to the Volume-Proportions.—W. Müller-Erbach.—The author concludes that, as far as the heavy metals are concerned, the degree of the affinity for oxygen can be more accurately results thus obtained are contradictory to light metals the results thus obtained are contradictory to the older tables of affinity; so that, for the class of oxygen compounds in question, the deduction of the affinities from the contractions appears the more trustworthy.

Incomplete Combustion of Gases.—Konrad Botsch.—This paper is incapable of useful abridgment.

Contributions to the Knowledge of the Benzoyl Compounds.—O. Doehner.—In this memoir the author examines the benzoyl derivatives of the phenols, including benzo-phenol and some of its salts, benzhydryl-phenol, the action of the benzoyl chloride upon phenyl acetate, the behaviour of benzoyl chloride upon resorcin, benzo-resorcin and its derivatives, benzo-pyrocatechin, and dibenzo-hydroquinone. He then passes to benzo-aniline, phthalyl-benzo-anilide, benzo-phenyl-isouitil, benzo-phe-

nyl-sulphurea, and the transformation of benzo-aniline into benzo-phenol. Lastly, he investigates benzoyl-benzoic acid.

On Combinations of the Carbo-hydrates with Alkalies.—Dr. Th. Pfeiffer and B. Tollens.—The authors examine successively the combinations of the alkalies with starch, with cane-sugar, with amylodextrin, with dextrin, and inulin. They conclude that a conclusion may be formed as to the molecular magnitude of the substances of the starch series by the aid of the alkaline compounds of these carbo-hydrates. The formulae which they have deduced may perhaps be considered merely as minimal quantities. Starch may be considered as $C_{42}H_{40}O_{20}$, including four starch-groups $C_6H_{10}O_5$. The formula of cane-sugar, $C_{12}H_{22}O_{11}$, is confirmed. Inulin requires a formula with 12 atoms of carbon, and cannot therefore be placed parallel with starch. The molecular magnitude of dextrin is much smaller than that of starch, and approaches more to that of the sugars and of inulin. Amylodextrin sodium prepared from crude amylodextrin has given figures which approximate to those of the corresponding starch compounds. Amylo-dextrins obtained by freezing, precipitation, &c., give figures agreeing more or less with those of dextrin, inulin, and cane-sugar.

Bismuth-Iodide Compounds of Organic Bases.—K. Kraut.—Not susceptible of useful abstraction.

On Anhydro-Compounds.—(A continuation).—H. Höbner.—The author examines first the anhydro-compounds of para-toluylic acid and the diamides. Secondly, para-toluylic acid and toluylene-diamine; para-toluylic acid and xylylene-amine; the amido-anhydro compounds; anhydro-benzamido-toluylic acid, anhydro-salicyl-diamidobenzol; anhydro-bases and iodine; mono- and di-alkyl compounds; and the anhydro-compounds of the phenols.

On Morphine.—E. v. Gerichten and H. Schrötter.—On distilling morphine with zinc powder the authors obtained, along with pyrral, amine bases, ammonia, pyridin, quinolin (?), also phenanthren to the extent of 3 to 4 per cent of the weight of the morphine, and 0.5 per cent of a base which they suspect to be phenanthren-quinolin.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome viii., No. 95.

Leçon on Electro-Metallurgic Procedures.—H. Bouillet.—An illustrated survey of galvano-plastic processes.

Manufacture of Commercial Aluminium Sulphate, and the Means of Ascertaining its Purity.—M. Debray.—Pure alumina for the manufacture of aluminium sulphate free from iron, is obtained as a secondary product of the treatment of cryolite (sodium aluminium fluoride) with milk of lime. The products are sodium aluminate and insoluble calcium fluoride. Deville prepared sodium aluminate by calcining bauxite (a mixture of alumina and ferric oxide) with a very caustic soda-ash. It is useful that the bauxite should be free from silica. The method used in England, i.e., precipitation of the iron by potassium ferrocyanide, is practicable only where fuel and sulphuric acid are cheap. There is the further disadvantage that the Prussian blue settles slowly and retains much alumina. Perroz proposed to precipitate the ferric oxide by gelatinous alumina in excess. In this manner there is formed a basic sulphate containing very little iron. Still the purification is not absolute. A neutral aluminium sulphate has been lately sold, which does not give the characteristic precipitate of ferric salts with ferrocyanide, though far from being free from iron. It is a mixture of aluminium, zinc, and ferrous sulphates, and gives a blue precipitate with potassium ferri-cyanide. If the alumina contained in such a product is precipitated with ammonia, it retains as much as 25 per cent of its weight of zinc oxide, and may thus appear to contain 15 per cent of alumina instead of 12.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. x., Part 7.

Purification of Sewage by Precipitation.—Dr. W. Wallace.—Translated from the CHEMICAL NEWS.

Manurial Experiments for Determining the Value of the Phosphoric Acid Soluble in Ammonium Citrate.—Dr. E. v. Wolff, Dr. J. König, and others.—The general average result is that the phosphoric acid soluble in water has been more efficient. The respective values of phosphoric acid soluble in water, precipitated and reverted, appear to be as 70, 62, and 17.

Manurial Experiments with Potassium Salts.—Prof. F. Farsky.—The action of these salts is beneficial except upon wet fields, but the result is more certain when they are accompanied with phosphoric and nitrogenous bodies. Potassium chloride was found more beneficial than the sulphate.

Value of Alpine Hay.—Dr. O. Kellner.—The albumenoid compounds in Alpine hay are more abundant than in the best hay in the low grounds, or in water-meadows, and the woody fibre is relatively less. The fatty matter is relatively plentiful, and its value is increased by the essential oils of the aromatic herbs.

Influence of Light upon Seeds.—Dr. Stebler.—The germination of many seeds of great agricultural importance is promoted by light.

A Crystalline Albumen in Pumpkin Seed.—Dr. G. Grüber.—From the *Journ. für Prakt. Chemie*.

Influence of Acids upon the Stability of Wines, and the Importance of Tannin for Red Wines.—E. Mach and K. Portele.—The authors examine the influence of tartaric, citric, malic, succinic, and acetic acids, and of tannin, upon the keeping properties of wine.

Action of the Ferment of Rennet under Various External Circumstances.—Prof. Ad. Mayer.—The author finds the presence or absence of bacteria of little moment.

Vol. x., Part 8.

Researches on the Evaporation of Free Water, of the Water present in Arable Soils, and on the Transpiration of Plants.—Felix Masare.—When the soil is very wet it throws off more water vapour than does a sheet of free water. If moderately moist, the quantities are about equal, and if the soil is dry its evaporation is less. The transpiration of plants is a complicated phenomenon, determined partly by physical and partly by physiological conditions.

MEETINGS FOR THE WEEK.

MONDAY, 20th.—London Institution, 5.

Medical, 8.30.

Society of Arts, 8. "Recent Advances in Photography," by Capt. W. de W. Abney, F.R.S.

TUESDAY, 21st.—Institute of Civil Engineers, 8.

Pathological, 8.30.

Royal Institution, 8. "The Mechanism of the Senses," by Prof. J. G. M'Kendrick.

WEDNESDAY, 22nd.—Society of Arts, 8. "The Production and Use of Gas for Purposes of Heating and Motive Power," by J. Emerson Dawson.

Geological, 8.

THURSDAY, 23rd.—Royal, 8.30.

Philosophical Club, 6.30.

Royal Institution, 8. "Geographical Distribution of Animals," by Dr. P. L. Sclater.

Society of Arts, 8. "Methods and Standards of Photometry," by Harold B. Dixon, M.A.

London Institution, 7.

FRIDAY, 24th.—Royal Institution, 8. "Sir B. C. Brodie's Researches on Chemical Allotropy," by Professor Odling, 9.

SATURDAY, 25th.—Royal Institution, 8. "The Iliad and Odyssey," by W. Watkins Lloyd.

Physical, 3. "On the Influence of the Form of Conductors on Electric Conduction Resistance," by G. Gore; "On Faure's Accumulator, and on a Simplified Form of Dispersion Photometer," by Profs. Ayrton and Perry.

THE CHEMICAL NEWS

VOL. XLV. No. 1161.

ON IMPACT WITH A LIQUID SURFACE.*

By A. M. WORTHINGTON, M.A.

THE apparatus previously used† by the author for following the progress of the splash of liquid drops impinging on a solid plate has been improved. The main principle of the method by which successive stages are isolated and rendered visible remains the same, viz., instantaneous illumination at any desired stage by means of the primary spark of an induction coil; but the timing of the illumination is now effected by a timing-sphere let fall simultaneously with the solid or liquid sphere whose impact is to be observed. The timing-sphere strikes a plate whose height can be adjusted, and thereby starts the mechanical action which results in the spark.

The time interval between successive stages of the disturbance can be measured to within a few thousandths of a second.

The significant portion of the whole series of changes in most of the splashes observed is comprised within about one-third of a second. The impact of both solid and liquid spheres has been studied, and is illustrated by several series of drawings which accompany the paper.

Milk drops falling into water were found to produce a similar disturbance to that resulting from the impact of similar water drops, and were used for the sake of distinguishing the original liquid of the drop from that into which it fell. With a drop about five millims. in diameter, falling from less than one metre, an annular rim is raised at the first moment of impact, bounding a hollow, which is afterwards characterised by regularly disposed radial ribs and arms, at the bottom of which the drop descends, passing below the surface and becoming completely submerged, to emerge again at the head of a column of adherent liquid, and with its upper portion apparently unwetted by the liquid with which it has been covered. The column then subsides, and the liquid of the original drop is seen to pass into the well-known vortex ring which descends through the liquid.

The influence of velocity of impact in modifying the phenomenon is shown by the drawings.

When the drop is large, and the fall considerable, the rim thrown up takes the form of a hollow crater-like shell of liquid, the mouth of which closes over the drop, imprisoning air which may remain as a bubble on the surface. This is the bubble seen when large rain drops fall into water. Observations of the bursting of this bubble confirm incidentally the explanation lately given by Mons. J. Plateau of the manner of bursting of a soap bubble.

The splash of a milk drop in petroleum and in olive oil is also described. The course of phenomena is very similar to that in water, modified however by the greater or less mobility of the liquids in question.

The impact of solid spheres is then described. The nature of the disturbance produced, with a given velocity of impact, is found to depend entirely on the state of the surface of the sphere.

A polished and perfectly dry sphere of ivory or marble one to three centims. in diameter, let fall from a height not exceeding one metre, is apparently wetted at once, and is seen to be sheathed with liquid before the whole is below the average level of the surface. The disturbance of the surface is very slight.

The same sphere if *rough* or *wet* with the liquid in

question, behaves quite differently, making a very deep depression, similar at first to that produced by a liquid drop, which finally becomes an almost cylindrical column of air within the liquid, part of which afterwards rises as bubbles while a portion descends in the wake of the sphere.

The influence of roughness in hindering the spread of liquid over the surface of the impinging sphere is then pointed out.

At the close of the paper an explanation is put forward of the radial ribs, arms, and striæ which are a notable feature of all splashes. Measurements of the annular rim bordering a thin central film, into which a drop falling on to a plate passes,* show that the number of the lobes and arms which are subsequently observed agrees well with the number of drops into which such an annulus would theoretically tend to split if unhindered by friction with the plate on which it rests, and it is then pointed out that the effect of the connecting film would be exactly such as to counteract the influence of this friction.

In the same way the radial striæ and ribs which characterise the hollow formed round a drop or solid sphere impinging on a liquid surface, are accounted for by the instability of the annular rim of the hollow, which through its tendency to cleave into a definite number of drops, determines a corresponding number of lines of easiest flow, at each of which a rib or arm is developed.

The author has observed that after the details have been once revealed by the method of instantaneous illumination, it is not difficult to identify the broad features of any splash that may occur by attentive observation in continuous light. Such observation may afford valuable information as to the condition of the surface of a solid,

GELATIN JELLY AS A DIALYSER.

By R. C. WOODCOCK, F.C.S., F.I.C.

JELLY prepared from gelatin has been employed by Dr. Dupré for the separation of artificial colouring matters in wines, but, so far as I am aware, its application to ordinary dialysis has never been carried out. Its use in toxicological chemistry may, however, demand some attention as the following experiments will show:—

A mixture was made of four different soups—thick and clear—about one and a half pints in all, together with boiled rice and macaroni; a little pepain and pancreatin was added, the mixture acidulated with hydrochloric acid and digested for some time at a temperature of about 90° F. One and a half ounces of concentrated hydrochloric acid was then run in, and the mass heated nearly to boiling, when it was allowed to cool and filtered. To the filtrate 0.5 gr. of strychnine was added, and the whole diluted to 10,000 grs. 5 grs. of this mixture (= 0.00025 gr. of strychnine) was diluted to 2500 grs. with water, and a gelatin cube placed in the solution, in a beaker. The jelly was prepared by making a 6 per cent solution of gelatin in hot water, allowing it to set in a suitable vessel, and then cutting a cube about 1½ inches. The solution was dialysed for sixty hours; the cube had swollen somewhat but was quite intact. The liquor was poured off, the cube well washed with distilled water, and heated in the beaker in a water-bath, and concentrated until a film of gelatin formed upon the surface of the liquid, when it was removed from the bath, cooled slightly, and strong alcohol added to about the same bulk as the liquid, a large proportion of the gelatin precipitated, and ether added until precipitation was complete. The ether and alcohol together amounted to about twice the volume of the concentrated gelatin solution. The mixture was well stirred, the gelatin adhered in a mass, so that the liquor poured off sufficiently clear without filtration. It was evaporated to dryness,

* Abstract of a Paper read before the Royal Society, February 16th, 1882.

† *Proc. Roy. Soc.*, vol. XXV., pp. 261, 498.

* *Proc. Roy. Soc.*, vol. XXV., p. 500; fig. 4.

and the residue moistened with concentrated sulphuric acid, which was kept at a temperature of 140° F. for eight hours, when a little water was added, and the mass filtered from a slight charred residue. The filtrate was made alkaline with strong ammonia and extracted with chloroform. The chloroform drawn off into a porcelain basin, and carefully evaporated so as to leave the residue as little distributed as possible; a few drops of concentrated sulphuric acid was added, when it was sufficiently colourless to test for strychnine with potassium bichromate. The reaction was *distinct*. When working with solutions containing ten times this quantity of strychnine, namely, 0.0025 gr., the reaction was *most* marked.

The above method has been tried many times with various quantities of strychnine and soup extract, and it has always been found that one treatment with concentrated sulphuric acid is sufficient to carbonise the foreign organic matter, which is never present in excessive quantities, and give a residue after filtration, &c., so slightly coloured with sulphuric acid that it may at once be tested for strychnine. This is probably due to the jelly being already saturated with colloidal matter, and thus only allowing at the most traces of colloids to dialyse into it; whereas the crystalloids have free entry. With an ordinary parchment dialyser comparatively large quantities of colloids do pass through.

Rodgers and Girwood's process as generally used—carbonising with sulphuric acid, neutralising with ammonia, extracting with chloroform, &c.—has frequently to be repeated many times before the extract is obtained sufficiently clean to be tested for strychnine, and this part of the process requires much time and attention.

In the presence of large quantities of colloids the jelly does not swell so much, but the strychnine readily dialyses into it.

A 1 per cent solution of gelose gives a good firm jelly, but at present I do not think that it works so satisfactorily as gelatin.

I hope shortly to carry the investigation further—with other alkaloids, metallic substances, &c. Experiments may prove that the time used for dialysing can be considerably shortened.

ON THE ACTION OF SALT ON MOLTEN COPPER OF VARIOUS DEGREES OF "DRYNESS."

By R. MONGER.

In making some experiments with salt and copper, I always noticed that if the button of copper were broken in two, it had the appearance of tough pitch metal, whether the metal was dry or not at the commencement of the experiment. And as the change in pitch of the metal can only be accounted for by the removal of the cuprous oxide it contained, I concluded that the salt might possibly dissolve it out of the copper, and proceeded to prove the correctness or otherwise of my reasoning, and now lay before you the results of some of the experiments undertaken for that purpose:—

1. Two pieces of tough pitch Barilla copper, weighing 150 grs. each, were dropped under melted salt in a Cornish assay crucible placed in a furnace, and allowed to remain for about ten minutes, and poured into a mould, cooled and the slag detached; the both buttons lost 0.47 per cent of their original weight.

2. Two pieces of best selected copper in a moderately dry state were heated in the same manner, and lost 1.125 per cent of their weight.

3. Two pieces of very dry best selected copper treated in the same manner lost 4 per cent of their weight.

4. The two buttons from the first experiment treated in the same manner lost nothing.

All these buttons were at tough pitch, and the copper in the slag of salt can be easily obtained by mixing the slag with a little red tartar, and melting. I believe the results of these experiments go far to prove the correctness of the conclusion I came to, for the following reasons:—

1. Salt brings dry copper up to tough pitch, being just what poling does, and no doubt exists as to the pole reducing the cuprous oxide.

2. The amounts lost by the same samples of copper were identical, showing the action to be a definite one.

3. The amounts lost increase as the dryness of the copper increases, and the only difference between dry and tough pitch coppers is in the amounts of cuprous oxide they contain.

4. The buttons from the first experiment, if my conclusion be correct, would be supposed to lose nothing, having already had their cuprous oxide abstracted, and this is what the fourth experiment shows.

Taking the loss suffered by the buttons as cuprous oxide, the percentages of oxygen contained in the samples would be as follows:—

| | | |
|-----------|---|--------------------|
| 1st Expt. | = | 0.052 tough pitch. |
| 2nd " | = | 0.125 rather dry. |
| 3rd " | = | 0.445 very dry. |
| 4th " | = | none tough pitch. |

I believe that this is a rapid and easy method for the estimation of cuprous oxide in copper.

Laboratory, Middle Bank Copper Works,
January 17, 1882.

ON THE BEHAVIOUR OF MANGANESE PEROXIDE AND CHLORIDE OF LIME ON IGNITION WITH CHROMIUM OXIDE AND SODIUM CARBONATE IN THE ABSENCE OF AIR.

By A. WAGNER.

SINCE manganese peroxide loses so much oxygen at a bright red heat that manganic oxide remains, the value of commercial manganese must be determinable from the proportion of oxygen lost. A direct measurement of the volume of the oxygen would, however, be attended with considerable difficulties. On the other hand, its oxidising action upon an ignited mixture of chromium oxide and sodium carbonate in the absence of air can be determined. I proceeded as follows:—In a combustion-tube, 25 cm. long and 8 to 9 cm. in width, were put some sodium hydro-carbonate, and then a very intimate mixture of a weighed quantity of pyrolusite (0.3 to 0.5 grm.) in very fine powder with an excess of chromium oxide and sodium carbonate, and a final stratum of the two latter ingredients only. The tube thus charged was connected by means of a cork with a small glass tube, to which again a gas-delivery tube was adapted by means of a caoutchouc tube and a screw-clip. The tube was then placed in the combustion furnace, and the above-mentioned gas-delivery tube with the clip open was made to dip into a little mercury, to exclude air. The sodium hydro-carbonate was first gently heated so as to expel air from the apparatus; then the mixture of chromic oxide and sodium carbonate at the front of the tube, and finally the stratum containing the weighed pyrolusite, was heated to redness. The full heat of the furnace was kept up for eight to ten minutes until the escape of carbonic acid from the gas-tube came to an end. The tube was then let cool, the caoutchouc pipe was closed by means of the screw clip to prevent the mercury from rising into the combustion-tube. The sodium chromate formed, which was obtained perfectly free from sodium manganate, was dissolved out from the insoluble residue, and the chromic acid was deter-

mined as chromic oxide by the ignition of mercurous chromate, according to Rose's method. The results obtained agreed fairly well with a determination of the same sample, according to the method of Fresenius and Will.

Of course if the temperature of ignition is not raised high enough, the results fall too low. The presence of lower oxides of manganese or of organic matter has also a disturbing effect.

The author does not draw any conclusion from his experiments with a single sample of chloride of lime.—*Zeitschrift. Analyt. Chem.*

BISMUTH OXIDE AS AN AGENT FOR OPENING UP SILICATES.

By WALTHER HEMPEL.

GARTON BONG has proposed to open up silicates by fusion with lead oxide, decomposing the unstable compounds formed with nitric acid, and after eliminating the lead by means of sulphuretted hydrogen, proceeding with the analysis in the ordinary manner. This method offers great advantages, since melting lead oxide quickly decomposes the most refractory silicates, even if not in the finest state of mechanical division. In conjunction with my assistant, Dr. R. F. Koch, I have made a number of experiments with this agent, and have found it very difficult to prepare a chemically-pure lead oxide. The red lead and the litharge of commerce we found always containing silica along with other impurities. The preparation of chemically-pure lead oxide from metallic lead by dissolving it in nitric acid and igniting the nitrate thus formed, involves great mechanical difficulties, since the lead nitrate melts before decomposing, and froths strongly, so that small quantities only can be obtained in each operation. All these difficulties are overcome by substituting bismuth oxide for lead oxide, simply igniting the silicate in question with bismuth subnitrate.

This compound is easily obtained in a state of the utmost chemical purity, and it has the further advantage that it does not melt at its temperature of decomposition. The opening up can be performed in the smallest platinum crucibles, as the hyponitric acid liberated fumes slowly away and does not carry with it any of the substance. The resulting melt is dissolved in hydrochloric acid, whilst in the lead process nitric acid is required, which must be afterwards expelled.

Repeated experiments have shown that it is advisable to work with a large excess of bismuth oxide, so as to have a very basic melt, which is easily decomposed by means of hydrochloric acid. The operation succeeds easily if $\frac{1}{2}$ gram of a silicate is heated gently with 10 grms. of bismuth subnitrate till red fumes no longer escape, and is finally kept in fusion for about ten minutes. The melt is poured as far as possible whilst still liquid into a platinum capsule, cooling under cold water, and the mass thus obtained and the crucible are treated with concentrated hydrochloric acid. The solution thus obtained is evaporated to dryness for the elimination of silica; the residue is taken up with hydrochloric acid; the silica filtered off and washed with water acidulated with hydrochloric acid.

On diluting the filtrate with water the greater part of the bismuth is precipitated as oxychloride. It is filtered off, washed, and from this second filtrate the remainder of the bismuth is precipitated by means of sulphuretted hydrogen. The further treatment of the filtrate is effected in the ordinary manner.

In order to throw a light upon a possible error due to the volatilisation of the alkalis at the melting temperature of bismuth oxide, a felspar was decomposed by this method, and by the hydrofluoric process. The results were:—

| | | | | | | | |
|---|-------------------------|----|----|----|----|-------|------|
| W | bismuth— | | | | | | |
| | Potassa | .. | .. | .. | .. | 7.60, | 7.70 |
| | Soda | .. | .. | .. | .. | 4.71, | 4.72 |
| | With hydrofluoric acid— | | | | | | |
| | Potassa | .. | .. | .. | .. | 7.86, | 7.77 |
| | Soda | .. | .. | .. | .. | 4.70, | 4.84 |

The operation can be safely conducted in a platinum crucible if care be taken that it is not in a reducing atmosphere. If reducing gases are present, metallic bismuth is formed, which destroys the crucible. Silicates which contain organic matter must first be ignited with access of air. A number of meltings have been performed in the same crucible, which suffered no injury.

As bismuth is a costly metal it is prudent to work up all the precipitates into subnitrate. This may be conveniently done by melting the residues and the filters along with soda in a Hessian crucible, dissolved in nitric acid the metallic bismuth thus obtained and precipitating the solution with water as a basic nitrate.

Finally I must recommend that the decomposition of silicates should be effected under a draught-hood, as the bismuth oxide volatilises slightly at the melting-point, and the vapours seem to be very poisonous.—*Zeitschrift für Analyt. Chem.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING JANUARY 31ST, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOYTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

February 5th, 1882.

SIR,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the month of January on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 175 samples, three only were recorded as "very slightly turbid." The remaining 172 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from January 2nd to January 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 25 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 25 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 25 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 25 samples from the mains of the West Middlesex Company, the whole were found to be well filtered, clear, and bright.

Of the 25 samples from the mains of the Lambeth Water Company, one was recorded as "very slightly turbid," the remaining 24 being well filtered, clear, and bright.

Of the 23 samples from the mains of the Grand Junction Company, the whole excepting one which was "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the Southwark and Vauxhall Company, the whole excepting one which was recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It is observable that the gradual increase which began in the month of October, both in the proportion of organic carbon and the degree of brown tint, reached its maximum in the month of December, since when there has been a return in these particulars towards the more usual condition of the water.

We have the honour to remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,

WILLIAM ODLING,

C. MEYNOTT TIDY.

CELESTIAL CHEMISTRY FROM THE TIME OF NEWTON.*

By T. STERRY HUNT, LL.D., F.R.S.

(Concluded from p. 76.)

If now we look to the third book of the "Principia," we shall find in proposition 41 the remarkable chemical argument by which Newton was led to regard the interstellar ether as affording "the material principle of life" and "the food of planets." Considering the exhalations from the tails of comets, he supposes that the vapours thus derived, being rarefied, dilated, and spread through the whole heavens, are by gravity brought within the atmospheres of the planets, where they serve for the support of vegetable life. Inasmuch, moreover, as all vegetation is supported by fluids, and subsequently by decay is, in part, changed into solids, by which the mass of the earth is augmented, he concludes that if these essential matters were not supplied from some external source they must continually decrease, and at last fail. This vital and subtle part of our atmosphere, so important, though small in amount, he then supposed might come from the tails of comets.†

This appeared in the first edition of the "Principia," in 1687. It was not until later that the conception of exhalations from other celestial bodies took shape in the mind of Newton, as we may learn from the "Optics." Thus, in the first edition of this work, in Query 11, the sun and fixed stars are spoken of as great earths, intensely heated, and surrounded with dense atmospheres which, by their

weight, condense the exhalations arising from these hot bodies. To this Query is added, in 1706, the suggestion that the weight of such an atmosphere "may hinder the globe of the sun from being diminished except by the emission of light;" while in the second English edition, in 1718, we find a further addition, in the words "and a very small quantity of vapours and exhalations." A similar change of view appears in the query now numbered 28, wherein we read of "places [almost] destitute of matter," and also that "the sun and planets gravitate towards each other without [dense] matter between." In these quotations the two words in brackets are wanting in the edition of 1706, and first appear in that of 1718; while the language which we have in a previous page quoted from this same Query is found in the edition of 1706.

The Queries now numbered 17-24 appeared for the first time in the edition of 1718, and herein we find, in 18, the ethereal medium spoken of as being "by its elastic force expanded through all the heavens." Of this medium, "which fills all space adequately," he asks, "may not its resistance be so small as to be inconsiderable," and scarcely to make any sensible alteration in the movements of the planets? This complex ether of the interstellar space was thus, in the opinion of Newton, made up in part of matter common to the planetary and stellar atmospheres, the origin and importance of which is concisely stated in the paragraph which appears for the first time in 1713, in the second edition of the "Principia," in the third book, at the end of proposition 42, here much augmented. In this statement, which serves to supplement and complete that already made in 1687, in proposition 41, we read that the vapours which arise alike from the sun, the fixed stars, and the tails of comets, may by gravity fall into the atmospheres of the planets, and there be condensed, and pass into the form of salts, sulphurs (i.e., combustible matters), tinctures, clay, sand, coral and other terrestrial substances.‡

The conception of Newton, who—while rejecting alike the plenum of the Cartesians, with its vortices and an absolute vacuum—imagined space to be filled with an exceedingly attenuated matter, through which a free circulation of gaseous substances might take place between distant worlds, has found favour among modern thinkers, who seem to have been ignorant of his views. Sir William Grove, in 1842, suggested that the medium of light and heat may be "a universally diffused matter; and subsequently, in 1843, in the chapter on Light in his "Essay on the Correlation of Physical Forces," concluded with regard to the atmospheres of the sun and the planets, that there is no reason "why these atmospheres should not be, with reference to each other, in a state of equilibrium. Ether, which term we may apply to the highly attenuated matter existing in the interplanetary spaces, being an expansion of some or all of these atmospheres, or of the more volatile portions of them, would thus furnish matter for the transmission of the modes of motion which we call light, heat, &c.; and possibly minute portions of the atmospheres may, by gradual accretions and subtractions, pass from planet to planet, forming a link of material communication between the distant worlds of the universe. Subsequently, in his address as President of the British Association for the Advancement of Science, in 1866, Grove further suggested that this diffused matter may become a source of solar heat, "inasmuch as the sun may condense gaseous matter as it travels in space, and so heat may be produced."

Humboldt, also, in his "Cosmos," considers the existence of a resisting medium in space, and says "of this impeding ethereal and cosmical matter," it may be supposed

* Read before the Cambridge Philosophical Society, November 28, 1881, and reprinted from its *Proceedings*.

† "Vapor enim in aestiva illis liberis perpetuo rarefactis, ac dilatatur. Quæ ratione fit ut cauda omnia ad extremam superiorem latior sit quam iuxta caput committitur. Et aënis rarefactione vaporem perpetuo dilatatum diffundit tandem et aspergi par coelos universos, deinde paulatim in planetas per gravitatem suam attrahi et cum eorum atmosphaeris misceri, rationi consentaneum videtur. Nam quædam modum maris ad constitutionem Terræ hujus omnino requiruntur, idque ut ex his per calorem Solis vapores copiose satis existerent, qui vel in nubem coacti densiusque pluvius, et Terram omnem ad præcreationem vegetabilium irrigari et nutrant; vel in frigida montium verticibus condensati (ut aliqui cum ratione philosophantur) ecurrant in fontes et flumina; ne ad conservationem marium et humorum in planetis requiri videtur cometæ, ex quorum exhalationibus et vaporibus condensatis, quævis liquora per vegetationem et putrefactionem consumuntur et in Terram aridam convertitur, continuo suppleri et refici possunt. Nam vegetabilia omnia ex liquoribus omnino creantur, dein magis ex parte in Terram aridam per putrefactionem accedunt, et limus ex liquoribus putrefactis perpetuo decedit. Hinc moles Terræ aridæ indies augetur, et liquoris, nisi aliunde augmentum sumerent, perpetuo decrescere deberent, ac tandem deficiunt. Porro supplet spiritum illum, qui æris nobis parvissima est, sed subtilissima et optima, et ad rerum omnium vitam requiritur, ex cometis præcipue venire."—Newton, "Principia," lib. III., prop. xli.

‡ Compare this with Prop. 2, Book III. of the "Principia."

§ "Vapores autem, qui ex Solis et stellis fixis caudis extanturum oïentur, incidere possunt per gravitatem suam in atmosphaeras planetarum, et, si condensari et converti in aquam et spiritus humidos et subinde per lentem calorem in sales, et sulphura, et tincturas, et limum, et cinem, et argillam, et arenam, et lapides, et coralla, et substantias à his terrestres paulatim migrare."—Newton, "Principia," lib. III., prop. 18.

that it is in motion, that it gravitates, notwithstanding its great tenuity, that it is condensed in the vicinity of the great mass of the sun, and that it may include exhalations from comets; in which connection he quotes from the 42nd proposition of the third book of the "Principia." He further speaks comprehensively of the "vaporous matter of the incommensurable regions of space, whether, scattered without definite limits, it exists as a cosmical ether, or is condensed in nebulous masses and becomes comprised among the agglomerated bodies of the universe."* Humboldt also cites in this connection a suggestion made by Arago in the "Annuaire du Bureau des Longitudes" for 1842, as to the possibility of determining, by a comparison of its refractive power with that of terrestrial gases, the density of "the extremely rare matter occupying the regions of space."†

In 1854 Sir William Thomson published his note "On the Possible Density of the Luminiferous Ether,"‡ wherein he remarks "that there must be a medium of material communication throughout space to the remotest visible body is a fundamental conception of the undulatory theory of light. Whether or no this medium is (as appears to me most probable) a continuation of our own atmosphere, its existence cannot be questioned." He then attempts to fix an inferior limit to the density of the luminiferous medium in interplanetary space by considering the mechanical value of sunlight, as deduced from the value of solar radiation and the mechanical equivalent of the thermal unit. He concludes "that the luminiferous medium is enormously denser than the continuation of the terrestrial atmosphere would be in interplanetary space if rarefied according to Boyle's law always, and if the earth were at rest in a state of constant temperature, with an atmosphere of the actual density at its surface." The earth itself in moving through space "cannot displace less than 250 pounds of matter."

In 1870 W. Mattieu Williams exhibited his very ingenious work entitled "The Fuel of the Sun," in which, apparently without any knowledge of what had been written before with regard to an interstellar medium, he attempts to find therein the source of solar heat—the "solar fuel" of Newton. To quote his own language—"The gaseous ocean in which we are immersed is but a portion of the infinite atmosphere that fills the whole solidity of space, that links together all the elements of the universe, and diffuses among them light and heat, and all the other physical and vital forces which heat and light are capable of generating" (*loc. cit.*, p. 5).

Since the days of Newton, however, no one had hitherto considered the interstellar matter from a chemical point of view. In 1874, as already shown, the writer had, in extension of the conception of Humboldt that its condensation gives rise to nebulae, ventured the suggestion that from an ethereal medium having the same composition as our own atmosphere, the chemical elements of the sun and the planets have been evolved, in accordance with the views of Brodie, Clarke, and Lockyer, by a stoichiogenic process; so that in the language of Newton's Hypothesis, "all things may be originated from ether."

It was not, however, until 1878 that, from a consideration of the chemical processes which have gone on at the earth's surface within recorded geological time, I was led to another step in this enquiry. That all the de-oxidised carbon found in the earth's crust in the forms of coal and graphite, as well as that existing in a diffused state, as bituminous or carbonaceous matter, has come, through vegetation, from atmospheric carbonic acid, appears certain. To the same source we must ascribe the carbonic acid of all the limestones which, since the dawn of life on our earth, have been deposited from its waters. It is through the sub-aerial decay of crystalline silicated rocks, and the direct formation of carbonate of lime, or of car-

bonate of magnesia and alkalies which have reacted on the calcium salts of the primalval ocean, that all limestones and dolomites have been generated. These, apart from the coaly matter, hold, locked up and withdrawn from the aerial circulation, an amount of carbonic acid which may be probably estimated at not less than 200 atmospheres equal in weight to our own. That this amount, or even a thousandth part of it, could have existed at any one time in our terrestrial atmosphere since the beginning of life on our planet is inconceivable, and that it could be supplied from the earth's interior is an hypothesis equally untenable.

I was therefore led to admit for it an extra-terrestrial source, and to maintain that the carbonic acid has thence gradually come into our atmosphere to supply the deficiencies created by chemical processes at the earth's surface. Since similar processes are even now removing from our atmosphere this indispensable element, and fixing it in solid forms, it follows that except volcanic agency, which can only restore a portion of what was primarily derived from the atmosphere, there are on earth, besides organic decay, only the artificial processes of human industry which can furnish carbonic acid; so that but for a supply of this gas from the interstellar spaces now, as in the past, vegetation, and consequently animal life itself, would fail and perish from the earth for want of this "food of planets."

Such were the conclusions, based on an induction from the facts of modern chemistry and geology, which I enunciated in my papers in 1878 and 1880, already quoted in the first part of this essay. I was at that time unacquainted with the Hypothesis of Newton, and with his remarkable reasoning contained in the 41st proposition of the third book of the "Principia," in which he, so far as was possible with the chemical knowledge of his time, anticipated my own argument, and showed how and in what manner the interstellar ether may really afford the "food of planets," and, in a sense, "the material principle of life."

I have thus endeavoured to bring before the Philosophical Society of Cambridge a brief history of the development of this conception of an interstellar medium, and to show that the thought of two centuries has done little more than confirm the almost forgotten views of Newton. It is with feelings of peculiar gratification that I have been able to indite these pages within the very walls of the college in which our great philosopher lived and laboured, and where, combining all the science of his time with a foresight which seems well-nigh divine, he was enabled, in the words of the poet, "to think again the great thought of the creation."

Alkali, &c., Works Regulation Act, 1881.—The following circular has been sent by the Secretary of the Local Government Board to the owner, lessee, occupier, or other person carrying on any work to which the Alkali, &c., Works Regulation Act, 1881, applies:—Sir,—I am directed by the Local Government Board to refer to their Circular of the 31st of December last, in which they drew your attention to the requirements of the Alkali, &c., Works Regulation Act, 1881, with respect to the registration of the several kinds of Works to which the Act applies. I am directed to remind you that, under Subsection (3) of Section 11 of the Act, application for Certificates of Registration is required to be made in the month of January or February in every year; and that, under Subsection (6), the owner of any work which is carried on after the 1st day of April, 1882, without being registered, exposes himself to a penalty not exceeding Five Pounds for every day during which it is so carried on. If, therefore, your Works come within the Act, it is necessary that an application for a Certificate of Registration in respect of them should be made to the Board in the prescribed form, of which a copy is enclosed, without any further delay.—I am, Sir, your obedient servant, JOHN LAMBERT, Secretary.

* "Cosmos," Otté's translation, Harper's ed., vol. i., pp. 82, 86.

† *Ibid.*, vol. iii., p. 40.

‡ Trans. Roy. Soc. Edinburgh, vol. xxi., part I., and Ph. Mag., 1855, vol. ix., p. 36.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 16, 1882.

Prof. H. E. Roscoe, President, in the Chair.

DURING the evening a ballot was held. Dr. Hodgkinson and Mr. Kingzett being appointed scrutineers. The following gentlemen were declared duly elected:—H. J. Alford, H. L. Buckridge, A. Blaikie, J. J. Beringer, W. E. Bush, G. W. Davies, J. F. Heyes, W. Hamilton, T. Isherwood, H. H. Phillips, T. Pitt, H. Porter, G. McRobert, C. H. Ridsdale, V. O. Sells, L. T. Thorne, S. Young. The following certificates were read for the first time:—J. Brown, H. H. Crawley, U. K. Dutt, T. Donnelly, R. Mar, J. T. Smith.

During the evening the Chairman mentioned that the Council had proposed the following changes in the Officers of the Society for the ensuing year:—Dr. Gilbert, President; Dr. Schunck and Mr. P. Griess as Vice-Presidents; Drs. Atkinson and Japp, Capt. Abney, and Mr. O'Sullivan as Ordinary Members of the Council instead of Dr. Tidy and Messrs. Cartledge, Roberts, and Warington.

The following papers were read:—

"On Benzyl Phenol and its Derivatives (Part II.)," by E. H. KENNIE. In a previous paper the author suggested that from the great resemblance between the reactions exhibited by para-cresol and benzyl-phenol, the latter belongs to the para series of compounds. The present investigation has fully confirmed this view. The author has prepared and studied the following derivatives:—

Benzyl-phenol-sulphonic Acid.—On account of the unstable nature and great solubility of this substance it was found impossible to obtain it pure. Mono-nitro-benzyl-phenol was obtained in golden-yellow prisms melting at 74° to 75°. Its potassium salt is deepened when dried at 100°. Amido-benzyl-phenol; Dinitro-benzyl-phenol, melting at 87° to 88°. Its potassium salt is orange. By the action of concentrated nitric acid on this substance, trinitro-benzyl-phenol is obtained. The author then studied the oxidation of trinitro-benzyl-phenol with chromic liquor, &c. By the action of nitric acid on nitro-bromo-benzyl-phenol, ortho-brom-dinitro-phenol was obtained, instead of trinitro-benzyl-phenol. When nitric acid acts on potassium bromo-sulphonate, the same nitro-bromo-derivative is obtained as when bromine acts on the potassium nitro-sulphonate. The formulae of the bromo-sulphonate and of the nitro-sulphonate must therefore be symmetrical. This can only be the case if benzyl-phenol is a para derivative. Other considerations point to the same result, and, in addition, the author has been able to furnish a direct proof that benzyl-phenol is a para derivative. By the oxidation of benzyl-phenyl-methyl-ether with alkaline permanganate a neutral substance is obtained, melting at 61° to 62°. This body has the composition of methoxy-benzo-phenon. Now Grucarevic, and Merz and Doebner have shown that by treating phenol with two molecules of benzoyl chloride and some zinc chloride a benzoyl-phenyl-benzoate was obtained, which, on saponification, yielded potassium benzoate and para-oxy-benzo-phenon. Now if benzyl-phenol be a para-derivative, the methyl-ether of para-oxy-benzo-phenon must be identical with the body produced by the oxidation of benzyl-phenyl-methyl-ether. The author therefore prepared some para-oxy-benzo-phenon, melting at 134°, and converted it into the methyl-ethyl by KIO and Mel, &c., and found this methyl-ether to be identical with the substance mentioned above in every respect, melting at 61° to 62°, &c. The two substances being identical, benzyl-phenol must be a para-derivative.

"On the Chemical Examination of the Buxton Thermal Water," by J. C. THRESH. In a previous paper the author communicated the results of an examination of the sinter

deposited by the above water, and in the present paper completes the examination of the spring by a most elaborate analysis of the saline constituents of the water. The flow per minute is not less than 101 gallons. The density of the water is 0.99992. Full details are given as to the methods employed in the analysis. The final result may be tabulated as follows:—

| | Parts in 10,000 Water. |
|----------------------------|------------------------|
| Calcium bicarbonate | 2.0014 |
| Magnesium carbonate | 0.8587 |
| Ferrous carbonate | 0.0044 |
| Manganous carbonate | 0.0040 |
| Barium sulphate | 0.0069 |
| Calcium sulphate | 0.0373 |
| Potassium sulphate | 0.0888 |
| Sodium sulphate | 0.1205 |
| Lead sulphate | 0.0006 |
| Sodium nitrate | 0.0037 |
| Calcium fluoride | 0.0028 |
| Sodium chloride | 0.4412 |
| Ammonium chloride | 0.0003 |
| Magnesium chloride | 0.1361 |
| Sillicic acid | 0.1356 |
| Lithium | trace |
| Srionium | trace |
| Phosphoric acid | trace |
| Organic matter | 0.0033 |
| Free CO ₂ | 0.0287 |
| Free nitrogen | 0.0272 |
| Total | 3.9015 |

The author also quotes the analyses of previous observers.

"On Retrograde Phosphates," by F. J. LLOYD. It has long been known that in some superphosphates the percentage of soluble phosphate originally present gradually decreases. The phosphate which has thus become insoluble in water is termed retrograde phosphate. Two questions are connected with this change—What is the exact composition of these retrograde phosphates? and can retrograde phosphates be estimated? The author has directed his attention almost entirely to answering the second question. He gives a *resumé* of the subject up to the present time. The author first investigates the solvent action of an alkali, a neutral, and an acid solution of ammonium citrate on ground coprolites, bone-ash, and precipitated phosphates. He finds that while coprolites, bone-ash, and bone-meal are less soluble in an ammoniacal solution than in a neutral solution, precipitated phosphates are more soluble in the alkaline solution. The author next directed his attention to the effects produced by the quantity of citric acid and by the quantity of ammonia present on the solubility of the above substances. 20, 30, and 40 per cent solutions of citric acid were used, and the quantity of ammonia present was varied, so that in one case an excess of ammonia was present sufficient to neutralise one-fourth of the citric acid, and in the other an excess equal to one-half the citric acid. The author concludes that an ammoniacal solution of ammonium citrate, whatever its strength, does not act upon mineral phosphates or bone-ash, but is capable of dissolving precipitated calcium phosphate. The next question was to decide whether these ammoniacal solutions act upon the retrograde phosphates. After many experiments with the methods of Fresenius, Petermann, Joulie, &c., the author found that the most accurate results were obtained by extracting 1 grm. of the phosphate with 50 c.c. of a cold ammoniacal solution of ammonium citrate containing 30 or 40 per cent of citric acid, and that the error, whatever it may be, consists, not in finding more retrograde phosphate than actually exists, but in not finding all that is present.

"Contributions to our Knowledge of the Composition of Alloys and Metal Work, for the most Part Ancient," by W. FLIGHT. This paper consists of a series of analyses of various ancient coins, &c. (1) Facts relating to the

History of Copper-nickel Coinage. The author has analysed some old Bactrian coins, about 230 B.C. They contain about 77 per cent of copper, 20 per cent nickel, with cobalt and iron in smaller quantities. (2) Some curious Square Coins of Ancient India 500 B.C. were examined. These contained 89 per cent silver, 4 per cent copper, 4 per cent lead, with silver chloride, gold, and graphite. (3) A Figure of Buddha contained 57 per cent Ag, 4 per cent AgCl, 37 per cent Cu, with gold and graphite. (4) Bidrai Ware, India, from Secunderabad. This consists of boxes, or bottles, or bowls of an alloy containing 94 per cent Zn, 4 per cent Cu, 1.5 per cent Pb, into the surface of which thin sheet-silver is inlaid. (5) Koft Gari Work from the Punjab, near Cashmere. The groundwork consists of iron blued by heat, and with a design of gold and silver. (6) A Sickle found at the foot of a Sphinx at Karnak. Its composition was— SiO_2 , 11.9 per cent; Fe_2O_3 , 5.1; CaCO_3 , 0.1; Fe_2O_3 , 64.6; water, 18.2; nickel, trace. This was supposed to be one of the oldest pieces of iron in existence. (7) Piece of Iron found in the Air Passages of the Great Pyramid. The interest of these two specimens of old iron is that from their analyses they appear not to be of meteoric origin, but to have been manufactured. (8) Double Hook of Bronze found in an Air Passage of the Great Pyramid. It contained 99.5 per cent Cu. (9) Bronze Figures brought from Egypt by Mr. John Dixon, supposed to be of Ptolemaic origin. A figure of Isis contained 68.4 per cent Cu, 4.7 per cent Fe, 22.7 per cent Pb, 1.5 As, traces Ni and Sb, and 0.9 per cent Sn. Another bronze contained 82.2 per cent Cu, 15.8 per cent Pb, 2.0 per cent Sn. (10) Copper Spear-heads from Cyprus contained Cu 97 to 99 per cent, Fe 0.4 to 1.3 per cent, As trace to 1.3 per cent, &c. (11) Copper Axe-heads from near Bethlehem contained 99.5 per cent Cu. (12) Hebrew Shekel, weighed 14.27 grms., contained 97.6 per cent Ag, 0.6 per cent Au, 0.6 per cent Cu. (13) Various Cypric, Roman, and Greek Bronzes contained 78 to 87 per cent Cu, 8.5 to 10.9 per cent Sn, 1.5 to 9 per cent Pb. (14) Inca's Pin from a Mummy at Arica, 82 per cent Ag, 1.4 per cent AgCl, 16.1 Cu. (15) Bronze Bar from Temple in Bolivia, Cu 93.2 per cent, Sn 6.5 per cent.

"On the Dissociation of Chlorine," by A. P. SMITH and W. B. LOWE. In 1879 Meyer showed that the vapour-density of chlorine at 1200° to 1500° was two-thirds of its vapour-density at 600° . It occurred to one of the authors that if chlorine was passed through a tube into potassium iodide less iodine might be liberated when the tube was heated than when cold. The authors have tested this point, and conclude that less iodine is liberated by chlorine after heating to 1030° than by chlorine which has not been so heated; or, to use their own phraseology, 1 gm. of chlorine at 6° becomes 0.744 gm. Cl at 1030° . What becomes of the rest is not stated.

The Society then adjourned to March 2, when the following papers will be read:—"On the Luminous Incomplete Combustion of Ether and other bodies at Temperatures below Redness," by W. H. PERKIN; "On the Action of Aldehyde on Phenanthraquinone in Presence of Ammonia," by F. R. JAPP and F. W. STREATFIELD; "On the Application of the Aldehyde and Ammonia Reaction in Determining the Constitution of Quinone," by F. R. JAPP and F. W. STREATFIELD.

THE METEOROLOGICAL SOCIETY.

Monthly Meeting, Wednesday, February 15, 1882.

Mr. J. K. LAUGHTON, M.A., F.R.A.S., President, in the Chair.

The following gentlemen were balloted for and duly elected Fellows of the Society:—W. AVONBERG, J.P.; W. G. BIRCHBY; J. RAND CAPRON, F.R.A.S.; P. CROWLEY, F.Z.S.; W. W. CULCHETH, M. Inst. C.E.; D. CUNNINGHAM,

M. Inst. C.E., F.S.S.; S. CUSHING; W. N. GREENWOOD E. KITTO; J. MANSERGH, M. Inst. C.E.; G. OLIVER, M.D.; H. S. H. SHAW, Assoc. M. Inst. C.E.; G. W. STEVENSON, M. Inst. C.E., F.G.S.; and W. H. TYNDALL.

The Papers read were:—

"Notes of Experiments on the Distribution of Pressure upon Flat Surfaces Perpendicularly Exposed to the Wind," by C. BURTON, B.A., F.R.A.S., and R. H. CURTIS, F.R.S. In the present state of aero-dynamics it seems to be impossible to make an *a priori* investigation of the distribution of pressure on a surface exposed to the impact of the fluid in motion without introducing such limitations as render the solutions arrived at widely divergent from the results obtained by the experiments hitherto made. The authors therefore proposed to themselves to attack the problem from the experimental side: only by a method which, as far as they know, has not been applied in the case of air, viz., the application of Pitot's tube, suitably modified in form, to the simultaneous measurement of the pressures at the centre and at any eccentrically situated point of a pressure plate of known dimensions. The results of the preliminary experiments are given in the present paper.

"The Principle of New Zealand Weather Forecasts," by Commander R. A. EDWIN, R.N., F.M.S.

"The High Atmospheric Pressure of the Middle of January, 1882," by H. SOWERBY WALLIS, F.M.S.

The Electrical Thermometer lent by Messrs. Siemens Bros. for observing the temperature of the air at the summit of Boston Church tower was also exhibited.

CORRESPONDENCE.

RETROGRADE PHOSPHATES.

To the Editor of the Chemical News.

SIR,—With respect to Mr. Lloyd's paper on "Retrograde Phosphates," read last evening before the Chemical Society, I would draw attention to the unfairness of the manner in which the ammonium citrate is now generally employed on the Continent. The habit now usually—or, to say the least very frequently—is to specify a superphosphate as containing so much "soluble," so much "assimilable," and so much "insoluble." Now that portion characterised by the second of these terms, "assimilable," is estimated by means of a solution of ammonium citrate (say Joulie's), and is that portion of the phosphate which, though insoluble in water, is taken up by the ammonium citrate. Many Continental, and more particularly French, agricultural chemists assert this portion of the phosphate to be "assimilable," and state it as such in their analyses. Such may be the case, and it is even, I may say, probable that if the choice is to lie between two portions of tricalcic phosphate,—one of them soluble in neutral ammonium citrate, the other insoluble—the former would be found more easily assimilable than the latter; but the use of the word "assimilable" as applied to such soluble phosphate assumes this unfairly, and the expression has a pernicious tendency to mislead the public. Not only this, however. The ammonium citrate solution is even a better solvent for both aluminium and ferric phosphates than it is for calcic phosphate, and these which are, we may say, constantly present in large proportion in retrograde phosphates are taken into solution by the citrate even more readily than the calcic phosphate is; so that these phosphates—whose utility from an agricultural point of view has been contested by many, or denied entirely by some—are by this mode of treatment classed as "assimilable." If the general use of the ammonium citrate is to be accepted in this country, and I see no reason why it should not, affording as it does some distinction as to the solubility, and possibly the more ready assimilability, of those more insoluble portions of artificial manures—let those por-

tions of phosphate estimated by it be characterised simply as "soluble in ammonium citrate," and in no other manner, and let the misleading expression "assimilable" be once for all discarded. The farmer will soon learn by practical experience what is the agricultural value of the ammonium citrate test, and doubtless that part of a manure estimated by it will not fail to find its proper value in the market; but at least he will not have been victimised by a delusive misnomer. I believe I am right in stating that this ammonium citrate test is the invention of a large French manure manufacturer, and one can well understand this to be the case, seeing how favourable its indications are to the manufacturers' interests rather than to those of the farmer.—I am, &c.,

F. MAXWELL LYTE.

Science Club, 4, Savile Row,
February 17, 1882.

SACCHARIMETRY.

To the Editor of the Chemical News.

SIR,—There seems to me to exist a widespread misapprehension regarding the limits for the rational use of Clerget's method for correcting the readings of the optical saccharimeter, and an expression of dissent from my views on the subject, in your recent review of a book on sugar analysis, of which I am author, is the occasion of this communication, in which, with all deference to the reviewer, I desire to amplify the matter somewhat. The passage referred to in the above work, in mentioning Clerget's method, is as follows:—"It must be remembered that the process is entirely inapplicable when any optically-active body is present besides cane or invert sugar, and also if the invert sugar itself exists in an inactive condition as regards polarised light."

The process has been recommended directly or implicitly in many of the books and journals for the correction of the error caused by optically-active impurities in general, and one author has even employed it for sugars containing large proportions of commercial grade sugars, notwithstanding that this substance is dextrogyrate at all temperatures, and generally contains much dextrin and soluble starch with a dextro-rotation of about three times that of dextrose.

It appears to me that it is only necessary to refer to the experimental basis of the method to make perfectly clear the fact that the formula derived therefrom, and from which the table is calculated, admits and takes into account only the disturbing action of invert sugar of the variety produced by acids on cane sugar of known rotatory power at given temperatures; consequently any other body present, either before or after inversion, of a different optical power from the cane or invert sugars, or which acquires such property through inversion, will alter the legitimate conclusion which the method is adapted to give. Clerget (*Ann. Phys. Chim.* [3], xxvi., 175; *Ann. Chem. Pharm.*, lxxii., 145) found that cane sugar reading +100 on the saccharimeter if submitted to complete inversion by acids, showed -44°, making a difference of 144°. He also found that the rotation of the inverted sugar, unlike that of cane sugar, varied with the temperature, and to such an extent that, very approximately, for every degree Centigrade the temperature was raised, the rotation sank 0.5°, so that at 0° C. the action is expressed by $T = 144 - 1t$. If S represents the sum or difference of the readings before and after inversion, t the temperature of the inverted solution when tested, and R the corrected percentage of cane sugar, then—

$$144 - \frac{1}{2}t : 100 :: S : R,$$

whence—

$$R = \frac{200S}{288 - t}$$

from which formula the table was calculated.

The whole process thus stands strictly upon Clerget's experiment in which only two rotatory bodies have any

part, and the readings must be the resultant of the specific rotatory powers of these sugars and nothing else. The following is a list of some of the substances that may exist in a saccharine material to be tested, with the approximate specific rotatory powers; there are many more known to be optically active, but which have been little studied in this respect. If it is allowed that the above formula is based only on the optical properties of cane and invert sugar, it is hard to see how a mixture containing in addition one or all of the succeeding bodies, with rotative powers, not only varying largely, but also different in acid, neutral or alkaline solution, could give results at all agreeing with what should be expected from cane and invert sugar alone:—

| | | |
|-----------------------------|---------|---|
| Cane sugar | .. .. . | [α] _D 73.8 |
| Dextrose | .. .. . | " 52.5 |
| Invert sugar (gen. formula) | .. .. . | [α] _D $t = (27.9 - 0.32 t)$ |
| | | Tschschmid. |
| Maltose | .. .. . | [α] _D = 139.3 |
| Dextrin | .. .. . | [α] _D = 212 to 139 |
| Beet gum | .. .. . | Strongly to the left |
| Soluble starch | .. .. . | " " |
| Glutamic acid | .. .. . | [α] _D = 34.7 |
| Albumen | .. .. . | " = -35.5 |
| Aspariginic acid | .. .. . | [α] _D acid 25.16 |
| | | alkaline NaOH -2.22 |
| | | NH ₄ O -11.67 |
| Asparagine | .. .. . | [α] _D acid 35.09 |
| | | alkaline -7.50 |
| | | D neutral -6.23 |

A fact showing the unreliability of the process in many cases, and deduced from my own experience and the published results of others, is that the corrected percentage of cane sugar is often lower than the first reading, while theoretically the reverse should be the case, as invert sugar at all ordinary temperatures possesses a *laevo*-rotation, making the first reading too low.

Landolt,* a high authority on such subjects, states distinctly that the results given by Clerget's method are unreliable when optically-active bodies other than invert sugar are present, and that in beet-sugar syrups organic acids are set free on inversion, which turn the polarised ray partly to the right and partly to the left.

The inapplicability of the method when only inactive invert sugar exists in the solution consists in its being unnecessary.—I am, &c.,

J. H. TUCKER.

Philadelphia.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 4, January 23, 1882.

Explosive Wave.—M. Berthelot.—The author holds that his recent experiments on the propagation of explosive phenomena in gases reveal the existence of a new kind of undulatory movements of a mixed order, produced by a certain concordance of physical and of chemical impulses within matter which is undergoing transformation. The speed of the explosive wave is totally different from that of sound-waves propagated in the same medium.

Spectroscopic Observations by Mono-chromatic Light.—C. V. Zenger.—The author has shown the power of dispersion presented by combining in a parallelipedon

* "Optische Drehungsvermögen, p. 191; *Journ. Prakt. Chem.*, ciii., p. 22.

two prisms having very different indices for red and violet light, and equal indices for light of mean refrangibility. He finds that among the liquids which furnish at once a sufficiently powerful dispersion, a perfect transparency, and the total reflection of the red and the violet part, benzol and benzylene, combined with quartz, eliminate the extreme red, whilst pure anethol eliminates the extreme violet.

Remarks on the Note of MM. Mignon and Rouart on Processes of Coppering.—F. Weil.—The author endeavours to show that his system differs less from that of MM. Mignon and Rouart than their letter of Jan. 9th would seem to imply.

Determination of the Nodes in Columns of Vibrating Air by means of the Microphone.—J. Serra-Carpi.—Not suitable for abstraction.

No. 5, January 30, 1882.

Combination of Carbonic Acid with Water.—S. Wroblewski.—Whilst examining the solubility of carbonic acid in water under high pressures, the author has found evidence of the existence of a hydrate of carbonic acid, easily dissociable and capable of being formed by pressure, like Ozier's hydrochlorate of hydrogen phosphide. This hydrate probably contains equal volumes of carbonic gas and of watery vapour, but this point is not yet directly established.

Silico-molybdic Acid.—F. Parmentier.—The author has isolated silico-molybdic acid, perfectly crystallised, in the shape of yellow cubo-octahedra, without action upon polarized light. They melt about 45° in their water of crystallisation, and are decomposed below 100°. The acid is very soluble in water and in dilute acids, and forms crystalline salts with bases. Alkaline carbonates and ammonia in excess decompose it with a precipitation of silica. Silico-molybdic acid resembles phospho-molybdic acid in colour and crystalline form. But it is less stable. Ammonium phospho-molybdate is insoluble, whilst silico-molybdic acid gives no precipitate with ammoniacal salts, save in very concentrated solutions. Phospho-molybdic acid gives an insoluble compound with potassa, whilst silico-molybdic acid gives no precipitate, even in the most concentrated solutions of potassium salts. Salts of caesium and rubidium, even when present in small quantity along with other alkaline salts, may be detected by means of silico-molybdic acid. The rubidium silico-molybdate is slightly soluble, whilst the corresponding caesium salt is totally insoluble, by which means the two may be separated.

New Combinations of Aldehyds with Phosphonium Iodide.—J. de Girard.—By the action of propylic acetal upon phosphonium iodide the author obtains a compound, $(C_3H_7O)_2PH_4I$. He has ascertained that the propionic, salicylic, and benzoic aldehyds yield, on contact with phosphonium iodide, compounds of the same order.

Vapour-Density of Sulphuryl Perchloride.—J. Ogier.—The author concludes from his results that the true gaseous density of pyro sulphuryl chloride, not dissociated, below 200°, is equal to 3.72. The weight of a litre is therefore 4.809 grms., or for 22.3 litres 107.5 grms. The double formula, $S_2O_5Cl_2 = 215$ grms., to which the atomic weight O = 16 leads, cannot be admitted, except we assume at the same time that the gaseous molecule may occupy 8 volumes of vapour.

Formation of an Aldehyd-Aceton and of a Glycol of the Aromatic Series.—E. Burcker.—The new aldehyd-aceton is a faintly yellowish liquid of a pleasant odour and a burning taste. It boils at 235°, and is decomposed at a somewhat higher temperature. It is easily soluble in alcohol, ether, chloroform, and benzol, and is insoluble in water. It reduces the solution of silver nitrate, but does not combine with alkaline bisulphites. On treatment with nascent hydrogen it produces a diatomic alcohol, a glycol at once primary and secondary.

Researches on Pilocarpine.—M. Chastaing.—On treating pure pilocarpine with melting potassa there is formed methylamin, but no volatile base having the characters of conicine is generated. The other products are carbonic acid, butyric acid, and traces of acetic acid.

No. 6, February 6, 1882.

This issue is entirely taken up with a notice of the prizes awarded for the past year, and of those proposed for the present season, and the four succeeding years.

Journal für Praktische Chemie.
Nos. 21 and 22, 1881.

Contribution to the Knowledge of the Diazo-phenols.—Dr. C. Böhmer.—The author combats the assumption that the hydrogen of the diazo-compounds cannot be replaced without decomposition. He describes diazo-phenol hydrochlorate and nitrate, para-diazo-phenol hydrobromate and sulphate, para-diazo-dibrom-phenol, its hydrobromate, and the compound of the latter with platinum chloride, para-diazo-dibrom-phenol sulphate, ortho-diazo-dibrom-phenol with its hydrobromate, sodium para-diazo-dibrom-phenol-sulphonate, the corresponding silver and barium salts, para-amido-dibrom-phenol hydrochlorate, amido-dibrom-phenol, and phenol-brom-phenyl-ether.

Dibrom- and Tribrom-Ortho-amido-phenetol and some of its Derivatives.—R. Mehlman and P. Ehmichen.—The authors enumerate the bromised compound already known, and then describe the bromisation of ortho-amido-phenetol, the behaviour of bromised diazo-phenetols with water, dibrom-diazo-phenetol nitrate, dibrom-phenetol, and tribrom-diazo-phenetol nitrate.

Determinations of Chemical Affinity (Fifth Treatise).—Dr. W. Ostwald.—Not suitable for abstraction.

Decomposition of Glucose and Uric Acid by Alkali at the Temperature of Incubation.—M. Nencki and N. Sieber.—Glucose is decomposed, whilst sugars of the formula $C_{12}H_{22}O_{11}$ have a greater power of resistance. Cane-sugar remained unaffected. Proteine compounds underwent no profound decomposition on contact with dilute alkalies. On digestion for days with an excess of alkali, there was a slight escape of ammonia, and peptons were formed. Leucin, tyrosin, and glycocholl were not generated. Uric acid was rapidly decomposed by dilute alkalies.

Communications from the Agricultural Physiological Institution of the University of Leipzig.—These consist of a memoir on the quantitative determination of free acids in vegetable and animal fats, by F. Stohmann, and a paper by Dr. v. Rechenberg on the proportion of free fatty acids in organic fats.

Anthology of Modern Chemical Utterances.—H. Kolbe.

Nos. 1 and 2, 1882.

Calorimetric Studies.—Dr. W. Ostwald.—This memoir treats of the reciprocal action of neutral salts. The author remarks that Berthelot, in order to explain the reactions which are contrary to his principles, has latterly begun to regard even the most stable bodies as partially dissociated, whereby the principle totally forfeits its value for the prediction of reactions. The author complains of the recent misuse of the term dissociation in chemical treatises. Instead of confining it to its original significance, decomposition by heat, it is applied in all cases of partial decomposition by whatsoever agents occasioned.

On Parenosine, a New Nitrogenous Non-Phosphuretted Constituent of the Brain.—J. L. W. Thudichum.—The substance of this paper will be found in the *Annals of Chemical Medicine*, vol. ii.

Remarks on a Treatise by Eugen Parcus "On Certain New Brain Compounds."—J. L. W. Thudichum.—A sharp, but apparently not unjustifiable critique.

Derivatives and Decomposition-Products of Mucic and Dehydro-mucic Acids.—Dr. A. Klinkhardt.—The author finds that pure pyro-mucic acid, prepared from dehydro-mucic acid, and free from iso-pyro-mucic acid, gives with ferric chloride not a green colouration, but a reddish brown precipitate. He has examined the chloride and the amide of dehydro-mucic acid; its behaviour with bromine and with nitric acid; nitro-pyro-mucic acid, its ethyl ether, and its silver, barium, calcium, and lead salts, and the reduction of nitro-pyro-mucic acid by tin and hydrochloric acid, the results obtained being succinic acid, carbonic acid, and ammonium chloride.

Product of the Reduction of Succinyl Chloride and on Normal γ -Oxybutyric Acid.—A. Saytzeff.—The reduction-product obtained is butyrolacton. The author has examined its conversion into normal γ -oxybutyric acid and into normal butyric acid.

Two New Derivatives of Sulphurea.—M. Nencki and N. Sieber.—The compounds obtained are the sulphurea of methyl-acetylen-carbonic acid and sulphovinuric acid. The properties of both and the salts of the latter are described at some length.

A New Formation of Resocyanine.—W. Schmid.—On adding upon resorcin with acetic-acetic ether and zinc with the aid of heat, the authors obtained a compound which proved to be identical with Wittenberg's resocyanine.

Contributions to the Chemistry of the Chrom-Ammonia Compounds.—S. M. Jørgensen.—An account of the bromo- and iodo-purpureo-chrom salts.

Diallyl-ethyl-carbinol.—A. Smirinsky.—The author has obtained and examined this compound, which has been hitherto unknown. It is a colourless fluid having the composition $C_9H_{16}O$.

Eiedermann's Central-Blatt für Agrikultur-Chemie,
Vol. x., Part 8.

The Greatest Daily Quantities of Rain.—Hermann Ziemer.—At Colberg, Sept. 7, 1880, there fell 102 m.m. in seven hours; at Breslau, August 6, 1888, 114.6 m.m. At Klausthal, in the Harz, the daily maximum observed is 115 m.m., and at Hoheneschwand, in the Black Forest, 126 m.m.

Analysis of Rice Soils from Birmah.—R. Romanis.—From the CHEMICAL NEWS.

Influence of the Physical Properties of the Soil on its Percentage of Free Carbonic Acid.—Prof. E. Wollny.—Other conditions being equal the carbonic acid of the soil increases with the temperature and the moisture, so long as the latter does not restrict the quantity of oxygen in the pores of the soil necessary for the decomposition of the organic matter. The proportion of carbonic acid increases with the fineness of the particles of the soil.

Manurial Experiments on Turnips with Soluble and Insoluble Phosphoric Acid.—Dr. Prevost.—A paper read before the Cirencester Chamber of Agriculture.

Experiments on the Relative Value of Soluble and Insoluble Phosphates.

Application of Different Phosphates in the Cultivation of Swedes at Tubney Warren in 1869.—These two papers are translated from the *Journal of the Royal Agricultural Society of England*.

Most Rational Strength of Artificial Manuring for Potatoes and Beets.—Dr. E. Wild.—For potatoes the most rational manuring seemed to be 10 kilos. phosphoric acid + 5 kilos. nitrogen per quarter morgen, whilst for beets, double the above quantities are required.

Manurial Experiments on the Experimental Field of the Agricultural Institute of the University of Göttingen.—Prof. Drechsler.—These experiments relate merely to beets.

Determination of Fat in Milk by means of the Lacto-Butyrometer and the Areometric Method of Soxhlet.—Dr. M. Schmoger, Dr. Eggert, &c.—The use of the lacto-butyrometer is pronounced simpler than that of Soxhlet's apparatus, and the results are considered sufficiently accurate for practice.

Alleged Saccharification of Starch by Water under High Pressure.—Prof. F. Soxhlet.—The proportion of sugar formed is greater the less water acts upon 1 part of starch. It was found that the presence of a trace of free acid, as met with in the potato- and the wheat-starches of commerce, is necessary. If this acid is removed no sugar is generated.

The Acorn and the Helianthus Root in the Manufacture of Alcohol.—Dr. H. Dill.—Both common acorns freed from their shells and the tubers of *Helianthus tuberosus* are capable of being used as a raw material in distilleries.

Physiology and Morphology of the Alcoholic Ferments.—E. C. Hansen.—The author describes *Saccharomyces apiculatus* as distinguished from *S. cerevisia*.

Disturbance of Fermentation by Various Substances.—Prof. M. Märcker.—Amongst the bodies enumerated are acetic, formic, propionic, butyric, and capronic acid, even in traces.

The Bacteria in the Atmosphere.—P. Miquel.—From the *Comptes Rendus*.

Vol. x., Part 9.

Influence of Industrial Gases and Waste Waters upon Soils and Plants.—Prof. G. König.—The author gives the composition of the waste waters of a dye-works, of a wire-drawing establishment, and of pyrites washing. He discusses the influence of sulphurous acid gas, of the waste waters from zinc-works, and of solutions containing common salt.

By What Acid do Plants Effect the Solution of the Phosphates in the Soil.—H. Von Liebig.—The author maintains that this change is effected by oxalic acid, and he suggests potassium oxalate as a solvent for reverted phosphates in manures in preference to ammonium citrate.

Exhaustion of the Soil by Means of Soda Salt-petre.—Dr. A. Emmerling and Dr. G. Loges.—The exhaustion of the soil by a single application of a moderate dose of cubic nitre is very slight in degree. Its continued use requires the simultaneous application of phosphoric acid, and occasionally of potash.

Agricultural Value of Ground Leather.—Prof. A. Petermann.—Without condemning leather, the author recommends farmers who use it to convince themselves as to its special suitability, by check-experiments with manures of known efficacy.

Manurial Experiments on Oats with Steamed and Dissolved Bones.—Dr. A. Emmerling.—The best results were obtained with dissolved bones.

Action of Gypsum upon the Constituents of Wine.—R. Kaiser.—Almost the entire tartaric acid is withdrawn from the wine as an insoluble calcium salt. "Plastered" wines are, undoubtedly, to be considered as sophisticated, since one of their most essential and characteristic ingredients is withdrawn.

Can Magenta Completely Disappear from an Artificially Coloured Wine.—Dr. J. Nessler.—The author considers that, under certain circumstances, magenta may disappear in a few days so completely as not to be capable of detection. Or there may be found an upper stratum free from magenta, whilst this dye is present in the lower part of the cask.

Bulletin de la Société Chimique de Paris.
Tome 36, No. 12.

Remarks on the Preparation and the Use of Molybdenic Liquid.—M. Kupferschlaeger.—Among the methods proposed for preparing a stable molybdenum mixture may be mentioned that of Champion and Pellet, who dissolve 10 grms. of molybdic acid in 15 c.c. of ammonia, diluted with 8 c.c. of water, and then pour this clear solution drop by drop, and stirring continually, into 50 c.c. nitric acid diluted with 30 c.c. of water, and let the mixture stand for some days at 40° to 45°; so that it may deposit any silica or phosphoric acid present. The clear liquid is then preserved in a well-stoppered bottle. The author finds that, by still further increasing the quantity of water, adding 30 c.c. to the ammonia and 50 c.c. to the nitric acid, a very sensitive reagent is obtained, which does not deposit any sediment in the course of two months. He considers it unnecessary to add any acid, especially tartaric acid, to the solution of ammonium molybdate if it is free from phosphoric, arsenic, or silicic acid.

Among the methods of using the re-agent, he mentions the following as the simplest. The sample is dissolved in an excess of nitric and hydrochloric acid; there is poured into it a solution of ammonium molybdate (without nitric acid), the mixture is boiled and left to settle. In this manner the process is much simplified, as it is merely necessary to dissolve pure ammonium molybdate in water when required. The nitric or hydrochloric acid must contain no lead, silver, tin, or antimony, and no organic matter must be present, especially tartaric acid.

NOTES AND QUERIES.

Spurious Honey.—Can anyone tell me what is the composition of a material sold on the Continent as honey? It is quite clear, but does not taste like honey, and appears to contain glycerin.—W. H. MANN.

MEETINGS FOR THE WEEK.

- SATURDAY, 25th.**—Physical, 3. "On the Influence of the Form of Conductors on Electric Conduction Resistance," by G. Gore. "On Faure's Accumulator, and on a Simplified Form of Dispersion Goniometer," by Prof. Ayrton and Perry. "On the Electric Resistance of Carbon under Pressure," by Prof. S. P. Thompson.
- MONDAY, 27th.**—London Institution, 5.
— Medical, 8.30.
- TUESDAY, 28th.**—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 5.30.
— Royal Institution, 3. "The Mechanism of the Senses," by Prof. J. G. McKendrick.
— Society of Arts, 8. "Scientific and Technical Education in Russia," by Prof. J. F. Hodgkin.
- WEDNESDAY, March 1st.**—Society of Arts, 8. "The Teaching of Forestry," by Colonel G. F. Pearson.
— Royal Medical and Chirurgical, 8. (Anniversary).
— Pharmaceutical, 8.
— Obstetrical, 8.
- THURSDAY, 2nd.**—Royal, 4.30.
— Royal Institution, 3. "Geographical Distribution of Animals," by Dr. P. L. Sclater.
— Royal Society Club, 6.30.
— Chemical, 8. "On the Luminous Incomplete Combustion of Ether and other Bodies at Temperatures below Redness," by W. H. Perkin. "On the Action of Aldehyde on Phenanthraquinone in Presence of Ammonia," by F. R. Japp and F. W. Stretfield. "Application of the Aldehyde and Ammonia Reaction in Determining the Constitution of Quinones," by F. R. Japp and F. W. Stretfield.
- FRIDAY, 3rd.**—London Institution, 7. "Roman Antiquities in London," by Mr. A. Tyor.
— Geologists' Association, 8.
- SATURDAY, 4th.**—Royal Institution, 3. "The Iliad and Odyssey," by W. Watkins Lloyd.

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| Bore of Delivery Pipe .. | 4 in. | 4 in. | 4 in. | 4 in. | 4 in. | 4 in. | 4 in. |
| " Steam Pipe .. | 1 1/2 | 1 1/2 | 1 1/2 | 1 1/2 | 1 1/2 | 1 1/2 | 1 1/2 |
| Delivery in galls. per h ^r | 100 | 200 | 500 | 1500 | 3000 | 5000 | 10,000 |
| Price £ | 1 10 | 2 5 | 3 10 | 7 10 | 10 10 | 12 10 | 20 0 |

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THE CHEMICAL NEWS

VOL. XLV. No. 1162.

CHEMICAL THEORY OF GUNPOWDER.*

By H. DEBUS, Ph.D., F.R.S.

1. Dr. Jebb† mentions a manuscript as existing at Oxford, entitled "Liber ignium ad comburendos hostes," by Marcus Græcicus, probably written in the eighth century, wherein the preparation of gunpowder is accurately described, and Bellani reports that the English used cannon at the Battle of Crecy. Gunpowder, therefore, has been known more than a thousand years, and its use for the purposes of war more than five hundred; nevertheless, no chemical theory of the combustion of gunpowder has hitherto been proposed which will enable us to calculate the quantity of each of the chief products of combustion from the known composition of a given weight of powder, or the amount of heat generated during its metamorphosis. A theory which can solve these problems I have the honour to submit in the present paper to the Royal Society.

2. The constituents of gunpowder—saltpetre, charcoal, and sulphur—are transformed during combustion into the following products:—Potassic carbonate, potassic sulphate, potassic disulphide, potassic sulphocyanate, carbonic acid, carbonic oxide, nitrogen, sulphuretted hydrogen, marsh-gas, ammonia, and hydrogen.

The hydrogen compounds—sulphuretted hydrogen, ammonia, and marsh-gas, the free hydrogen and potassic sulphocyanate—do not, as a rule, amount together to more than about 2 per cent of the weight of the powder from which they have been produced; and as their formation is not the direct result of the reactions which cause the explosion of the powder, they are regarded as secondary products and not considered in a discussion of the chemical metamorphosis of gunpowder.

Besides the potassium salts mentioned, potassic hypsulphite has been found as one of the constituents of the solid residue left by powder after its explosion. According to experiments by the author, which have been confirmed by Noble and Abel, this salt is formed in considerable quantities from potassic sulphide during the analyses of the residues according to Bunsen and Schischkoff's method; and as it is decomposed at 225° C., it cannot be considered as one of the chief products of the combustion of gunpowder.

3. With regard to the products, potassic carbonate, potassic sulphate, potassic disulphide, carbonic acid, carbonic oxide, and nitrogen, the following problems have to be solved:—

(a.) To determine the reactions which cause the formation of these substances, and the order in which they succeed each other, and to represent the complete combustion of gunpowder by one chemical equation.

(b.) To calculate from the known composition of a given weight of powder of the volume of gas and the amount of heat generated during its combustion, and to ascertain the relative energies of powders of different composition.

The solution of each of these problems is described in the paper.

4. Noble and Abel‡ describe the quantitative relations of the products of combustion of a given weight of powder of known composition in the following words:—

"(a.) The proportions in which the several constituents of solid powder residue are formed are quite as much

affected by slight accidental variations in the conditions which attend the explosion of one and the same powder in different experiments, as by decided differences in the composition as well as in the size of grain of different powders.

"(b.) The variations in the composition of the products of explosion furnished in close chambers by one and the same powder under different conditions, as regards pressure, and by two powders of similar composition under the same conditions, as regards pressure, are so considerable, that no value whatever can be attached to any attempt to give a general chemical expression to the metamorphosis of gunpowder of normal composition.

"(c.) Any attempt to express, even in a comparatively complicated chemical equation, the nature of the metamorphosis which a gunpowder of average composition may be considered to undergo, when exploded in a confined space, would therefore only be calculated to convey an erroneous impression as to the simplicity or the definite nature of the chemical results and their uniformity under different conditions, while it would, in reality, possess no important bearing upon an elucidation of the theory of explosion of gunpowder."

"(d.) Very small-grain powder, such as F.G. and R.F.G., furnish decidedly smaller proportions of gaseous products than a large-grain powder, R.L.G.; while the latter again furnishes somewhat smaller proportions than a still larger powder, P, though the difference between the gaseous products of these two powders is comparatively inconsiderable."

Noble and Abel exploded successively portions of powder of the same description in their apparatus, and found considerable fluctuations in the relative qualities of the products of explosion in different experiments. These fluctuations they do not explain, but state that "slight accidental variations in the conditions which attend the explosion," have as much influence on the relative quantities of the constituents of the solid powder residue as decided differences in the composition of the different powders. And as the exact nature of these "slight accidental variations in the conditions which attend the explosion" is not known, they conclude the metamorphosis cannot be represented by a chemical equation.

The author of this abstract has described in the paper the causes of the variations in the relative quantity of the products of explosion, and has explained the experimental results of Messrs. Noble and Abel. And further, he has been able, with this knowledge, to represent the chemical metamorphosis of the English Service powders by an equation.

5. Noble and Abel assume that the samples of fine-grain and pebble powders used in their numerous experiments were, respectively, of the same composition, and that the samples of R.L.G. powder employed in their earlier experiments had the composition given under "I." and those used in the later experiments that given under "II." in the table below.

The composition of the same description of powder is, however, not constant.

I requested the late Mr. Wills to analyse pebble and R.L.G. powders from Waltham Abbey, and the results obtained by him, together with those of Noble and Abel, are given in the following table:—

| | R.L.G. | | | Pebble Powder. | |
|-----------------|---------------------|---------------|--------|----------------|--------|
| | Noble & Abel. I. | Wills. II. | Wills. | Noble & Abel. | Wills. |
| Saltpetre | 74.95 | 74.43 | 75.10 | 74.67 | 74.26 |
| Sulphur | 10.27 | 10.09 | 8.96 | 10.07 | 9.51 |
| Charcoal— | | | | | |
| Carbon | 10.86 | 12.40 | 12.09 | 12.12 | 11.38 |
| Hydrogen | 0.42 | 0.40 | 0.34 | 0.42 | 0.51 |
| Oxygen | 1.99 | 1.27 | 2.12 | 1.45 | 2.55 |
| Ash | 0.25 | 0.21 | 0.20 | 0.23 | 0.33 |
| Water | 1.11 | 1.05 | 0.85 | 0.95 | 0.76 |

* Abstract of the Bakerian Lecture delivered before the Royal Society, February 23.
† Poggendorff, *Gründriss der Physik*, 87.
‡ *Phil. Trans.*, cliv. (1873), p. 137.

* *Phil. Trans.*, cliv. p. 83.

The samples analysed by Noble and Abel were taken out of the *same barrel*, the one from the upper, the other from the lower parts. These two samples showed a difference of no less than 1.54 per cent of the weight of the powder in the amount of carbon they contain, or the weight of carbon is by one-seventh greater in the second than in the first sample. Mr. Wills found 1.31 per cent of sulphur less than Noble and Abel in the same description of powder. Such differences in the composition of samples of powder of the same nature, together with the usual errors attaching to complicated and difficult analytical operations, are almost sufficient to explain the variations in the proportions of the products of the combustion of gunpowder, as found by Messrs. Noble and Abel, without requiring a theory like the one proposed by M. Berthelot for that purpose.

6. Noble and Abel analysed the products of explosion by means of Bunsen and Schischkoff's method. The author has proved that by the treatment of the solid powder residue, according to this method, a portion of the potassic sulphide is converted into potassic hyposulphite, and under certain conditions into potassic sulphate. The quantities of the two salts so produced vary in different experiments. Hence, the fluctuations observed by Noble and Abel in the relative quantities of potassic sulphide, potassic sulphate, and potassic hyposulphite are partly, if not entirely, due to the method of analysis. Potassic hyposulphite is decomposed at temperatures above 225°; from this fact, as well as from a comparison of the oxygen in the original powder with that of the products of explosion, it follows that the potassic hyposulphite found in powder residues must be regarded as the product of the analytical method.

7. It is well known that the sulphides of potassium attack metals with great energy at a white heat. Noble and Abel exploded their powders in a hermetically closed steel cylinder at high pressures, and the products remained after explosion from one to two minutes in a fluid condition at a white heat in contact with the iron of the apparatus. These products contain potassic disulphide. The description given by Noble and Abel of their solid powder residues indicates that they contain ferrous sulphide. The absorption of a portion of the sulphur by the iron will increase the amount of potassic carbonate and diminish the quantity of potassic sulphide and disulphide. The quantity of sulphur so uniting with iron depends on pressure, time of cooling, and other conditions, and will vary in different experiments. We have, then, in the formation of ferrous sulphide, another cause of the fluctuation in the quantities of the products of explosion observed by Messrs. Noble and Abel.

8. It follows from the statements given under Nos. 5, 6, and 7 that there is no reason to assume that the chemical metamorphosis of gunpowder cannot be represented by an equation.

9. Noble and Abel calculate the total weight of the solid residue, which a given weight of powder can produce by its explosion, from the composition of a *portion* of the residue and the composition of the powder. They assume that the portions of powder of the same description used in different experiments were of the same composition. This is, according to the statements under No. 5, not the case. The calculated quantities of gas and solid residue which a given weight of powder can produce will, in consequence, be affected by certain errors. These errors compensate each other if the mean of many experiments is taken.

10. Portions of powder taken from different parts of the same barrel show, according to Noble and Abel's analyses, great differences in their composition than samples of different descriptions manufactured at Waltham Abbey, pebble, rifle fine-grain, rifle large-grain, and fine-grain powder; hence, we are justified in taking the mean of the analyses of these powders, and expressing thereby the composition of the English Service powder. The mean

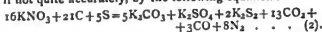
of the analyses of Noble and Abel, and Wills, can be represented by the symbols—



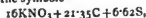
if hydrogen, oxygen, and ash of the charcoal, and the hygroscopic moisture of the powder are neglected.

11. From evidence described in the paper it follows, with a high degree of probability, that during the combustion of gunpowder potassic disulphide, and not monosulphide, as is usually assumed, is formed.

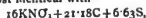
12. If the errors arising from the analytical method are corrected as explained in the paper, if allowance is made for the sulphur which has united with the iron of the apparatus, and, finally, if, for the reasons adduced under No. 9, the mean is taken of the thirty-one analyses published by Noble and Abel, then the explosion of the powders of Waltham Abbey, as conducted by Noble and Abel in a confined space, can be represented very nearly, if not quite accurately, by the following equation:—



1.63 atoms of the sulphur contained in the powder have united partly with hydrogen and formed sulphuretted hydrogen, partly with iron and produced ferrous sulphide. The entire amount of the oxygen contained in the charcoal is eliminated with hydrogen as water, the rest of the hydrogen either remains free or produces methane with carbon and ammonia with nitrogen. The composition of the powder, calculated from the mean composition of the products of explosion of thirty-one experiments, can be represented by the symbols—



which are almost identical with—



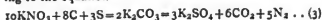
representing the mean composition of the powder found by direct analysis.

13. An increase of pressure during combustion appears to diminish the amount of carbonic oxide, and, in consequence, according to equation 8, to increase the quantities of potassic carbonate, potassic disulphide, and carbonic acid. These fluctuations in the quantities of the products of combustion are, however, *very small*, and may be neglected without serious error.

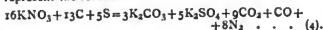
14. Craig had asserted that the nature of the products of explosion of gunpowder depended on the pressure developed during combustion. Karolyi, in order to test this assertion, made experiments with Austrian Service powder, and arrived at the conclusion that pressure had no influence on the quality or quantity of the products furnished by these powders.

The experimental results of Karolyi, and the differences between these results and those obtained by Noble and Abel, have enabled the author to develop a chemical theory of gunpowder competent to explain the observations of Bunsen and Schischkoff, Lieck, Karolyi, Noble and Abel, and other investigators, and which is in harmony with the thermo-chemical relations of the reacting substances.

According to this theory the combustion of gunpowder takes place in two stages, one succeeding the other. The reactions of the first stage cause the explosion of the powder. *Gunpowders which differ considerably in their composition are transformed during the first stage according to the equation—*



but as it is probable that at the same time some carbonic oxide is produced, the following would more correctly represent the reactions:—



The constituents of the powder, and of the products of combustion are, according to equation 4, nearly in the same ratios as they are according to 3.

During the first stage of the combustion potassic disulphide is not formed.

The oxygen of the potassic carbonate, potassic sulphate, and the carbonic acid, as represented by equation 3, stand to each other in the most simple possible ratios, if these substances are to be produced by the combustion of a mixture of saltpetre, carbon, and sulphur. In other words, equation 3 represents the most simple distribution of the oxygen of the decomposed saltpetre amongst the products of combustion produced during the first stage. And because these products are, according to equation 4, nearly in the same relative proportions as they are according to 3, it follows that the distribution of the oxygen of the saltpetre between potassic sulphate, potassic carbonate, and carbonic acid, as required by equation 4, corresponds nearly to the most simple ratios which can exist under the conditions of the experiments.

The oxygen of the potassic carbonate stands to the oxygen of the potassic sulphate and of the carbonic acid, according to equation 3, as—

$$1 : 2 : 2.$$

If a mixture of saltpetre, carbon, and sulphur shall produce, by its combustion, the greatest possible amount of heat, and if at the same time the products—potassic sulphate, potassic carbonate, and carbonic acid—shall be formed in such proportions that the heat of formation of one shall stand to the heat produced by each of the other two in the most simple ratio possible, then the combustion must take place according to equation 4.

The heat developed by the formation of potassic carbonate stands to that furnished by potassic sulphate and carbonic acid respectively as—

$$1 : 2'05,$$

$$1 : 1'04,$$

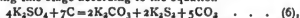
and

if the powder is transformed according to equation 4.

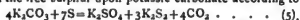
The relations between the quantities of oxygen in the chief products of combustion and those of the heat produced by their formation are, from a theoretical point of view, of the greatest interest.

15. Gunpowder, as a rule, contains more carbon and sulphur than is required by equations 3 and 4.

The carbon left free at the end of the first stage of the combustion now acts on the potassic sulphate formed during this stage according to the equation—



and the free sulphur upon potassic carbonate according to

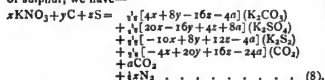


and some of the free carbon reduces carbonic acid to oxide.

These reactions constitute the second stage of the combustion of gunpowder; they are endothermic, heat is not evolved but rendered latent; they are not of an explosive nature, and, in practice, are probably seldom complete. During the second stage of the combustion the temperature of the products of explosion is diminished and the volume of the gas is increased.

16. The quantitative relations between the constituents of gunpowder and the chief products of combustion at the end of the second stage can be expressed by one equation.

If x , y , and z be positive numbers, and a represents how many molecules of carbonic oxide are formed by the complete combustion of a weight of powder containing x molecules of saltpetre, y atoms of carbon, and z atoms of sulphur, we have—



as the general equation of the complete combustion of gunpowder.

By means of this equation the chief products of combustion—potassic carbonate, potassic sulphate, potassic di-

sulphide, and carbonic acid—can be calculated from that portion of a given weight of powder which transforms itself into these products.

The correctness of the equation is proved by the agreement of the calculated numbers with those observed by Bunsen and Schischkoff, Linck, and Karolyi in their experiments on the explosion of gunpowder, and also with the corrected mean numbers derived from Noble and Abel's investigation.

17. The total volume of gas developed by the combustion of a given weight of powder, if calculated according to equation (8), is not affected to more than from one to two per cent if we put $a=0$, and in doing so we gain a considerable simplification of the equation. If V represents the volume of gas evolved by the combustion of a quantity of powder containing 16 molecules of saltpetre, y atoms of carbon, and z atoms of sulphur, and W the units of heat developed by the same weight of powder, we have, on the assumption that $a=0$,—

$$V = \frac{160 + 20y + 16z}{14} \quad (9),$$

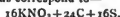
$$W = 1000[1827'154 - 16'925y - 8'788z] \quad (10).$$

The volume of gas becomes greater, and the amount of heat diminishes, when y and z are increased, and vice versa.

Quantities of saltpetre, carbon, and sulphur represented by the symbols—



produce the greatest amount of heat and smallest amount of gas, and such as correspond to—



the largest volume of gas and the smallest quantity of heat, if the mixtures are considered which can transform themselves during combustion according to equation (8), in which a is put = 0.

(8). The product of (9) and (10) divided by 2×1000 ,

$$\begin{aligned} \frac{V \times W}{2000} = & 10440'88 - 12'09y^2 + 1208'39y - 15'95z^2 + \\ & + 993'867z - 5'022z^2 = E \quad (11), \end{aligned}$$

will assume different values for powders of different composition. The energy of a mixture of saltpetre, carbon, and sulphur will be, *ceteris paribus*, proportional to the volume of gas, and also to the amount of heat produced during its combustion. Hence, the product of the two, E , may be used, according to the proposal of M. Berthelot, as a measure of the relative energies of powders of different composition.

(9). If in equation (8) x is put = 16, and $a=0$, we obtain—

$$\begin{aligned} 16(KNO_3) + yC + zS = & \frac{1}{2}y[64 + 8y - 16z](K_2CO_3) \\ & + \frac{1}{2}y[320 - 16y + 4z](K_2SO_4) \\ & + \frac{1}{2}y[-160 + 8y + 12z](K_2S_2) \\ & + \frac{1}{2}y[-64 + 20y + 16z](CO_2) \\ & + 8N_2 \quad (13), \end{aligned}$$

and from this, if the coefficients of the potassic carbonate, potassic sulphate, and potassic disulphide are put = 0, the equations:—

$$\begin{aligned} 64 + 8y - 16z = 0 \quad (14), \\ 320 - 16y + 4z = 0 \quad (15), \\ -160 + 8y + 12z = 0 \quad (16), \end{aligned}$$

These equations represent in a plane three sides of a triangle. The co-ordinates of points within this triangle represent quantities of carbon and sulphur, which can, with 16 molecules of saltpetre transform themselves according to equation (13), whereas the co-ordinates of points outside this triangle indicate mixtures which cannot do so, such mixtures containing either too much or too little of carbon or sulphur.

The co-ordinates of points on the sides of the triangle represent mixtures which will burn with the production of two, and those of the points of intersection of two sides with formation of only one potassium salt.

The two sides represented by equations (14) and (16) intersect in point $y=8$, and $z=8$. These values introduced into (13) give—



In the same manner we obtain for the point of intersection corresponding to equations (15) and (16) :—



and finally, the sides whose equations are (14) and (15), intersect in point $y=24$ and $z=16$, hence—

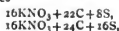


The geometrical construction of the coefficients of equation (13) possesses the great advantage of indicating by the co-ordinates of the points of a triangle the composition of the infinite number of mixtures of saltpetre, carbon, and sulphur which can transform themselves during combustion according to equation (13), and enables us to deduce *geometrically*, as is shown in the paper, the qualitative nature and the quantitative relations of the products of combustion, as well as the volume of gas and the amount of heat developed by each mixture.

(20.) It is proved in the paper that the composition of a powder which can transform itself during combustion according to equation (13), and for which E in equation (11) shall be a maximum, is indicated by the co-ordinates of the point of intersection of the sides of the triangle represented by the equations (14) and (15).

If, therefore, such quantities of powders of different composition are compared, which contain 16 molecules of saltpetre, the one composed of $16\text{KNO}_3 + 24\text{C} + 16\text{S}$ will possess the greatest energy.

(21.) If E is calculated for *equal weights* of two powders of different composition, the difference of the values of E is found to be *very small*, if the powders contain from 21 to 24 atoms of carbon, and from 8 to 16 atoms of sulphur for every 16 molecules of saltpetre. Equal weights of the two mixtures—



and

give for E [equation (11)] the values 16.84 and 16.95 respectively. If, therefore, a mixture of saltpetre, carbon, and sulphur is required, which shall possess the greatest or nearly the greatest amount of energy, and at the same time contain the smallest amount of carbon and sulphur compatible with this condition, theory would point to the mixture—



The gunpowders of most nations fluctuate about—



which numbers are very near those required by theory.

ON CÆSIUM.

ONE of the first fruits of spectrum analysis was the discovery of the two alkaline metals caesium and rubidium, by Bunsen and Kirchhoff. The salts of these metals were closely examined, and found to show a similarity with the compounds of potassium more complete than had yet been observed among analogous bodies. The two metals are the most electro-positive of all known substances, and form consequently the ultimate members of the electro-chemical series, being more positive even than potassium. With this property is naturally combined an exceptional affinity for oxygen, which, especially in the case of caesium, is so great that the isolation of the metal was found impossible, and the discoverers, being unable to separate it from the accompanying non-metals, had to content themselves with the examination of its compounds. Rubidium, however, was isolated by Bunsen, and was described as a light metal deceptively similar to potassium, but much more fusible.

Carl Setterberg has lately effected the isolation of caesium. His method was the electrolysis of a fused mixture of caesium and barium cyanides. Having relatively enormous quantities of the precious materials at command,—by means of a process of his own invention he has prepared 40 kilos. rubidium and 10 kilos. caesium-alum,—he has produced caesium as a metal very similar to the remaining alkali-metals, silver-white, very soft and ductile. Its melting-point is 265° , and its sp. gr. 1.88. On exposure to the air it ignites spontaneously, and if thrown upon water it burns like potassium, sodium, and rubidium. Setterberg has proved anew that in consequence of the affinity of the metal for oxygen, and the volatility of its salts, the preparation of caesium by igniting its carbonate along with carbon—according to the ordinary method for obtaining rubidium and potassium—is quite impossible.—*Annalen der Chemie und Pharmacie*.

NOTE ON THE VOLUMETRIC DETERMINATION OF NITROGEN.

By A. BERNTHSEN.

IF in volumetric determinations of nitrogen the requisite carbonic acid is evolved,—not in the combustion-tube, but by means of a special apparatus,—there is always obtained an excess of nitrogen due to the air present in the marble. This evil may be avoided by putting the marble first into a bottle with thick sides, covering it with water, and then evacuating it well under the water air-pump. In this manner the air is as good as totally expelled, especially if the bottle is shaken from time to time, so that the bubbles formed on the surface of the marble may be detached. The results obtained in this manner leave little to be desired on the score of accuracy.—*Zeitschrift für Analyt. Chemie*.

NEW METHOD FOR DETERMINING THE GYPSUM CONTAINED IN WINES.

By M. E. HOUDARD.

I SUBMIT to the Chemical Society of Paris a method which has rendered me substantial services for more than a year, for determining, in a quick and easy manner and with sufficient approximation, the proportion of potassium sulphate, or rather the corresponding quantity of sulphuric acid, found in almost all Mediterranean wines from the "plastering" carried on by the growers.

This method does not offer much interest from a scientific point of view, but it may prove important for all those who are concerned with the analysis of wines of ordinary consumption. It is based upon the formulae of M. Poggiale, modified in 1876 by M. Marty, Professor at Val de Grace; but in place of indicating merely if a wine contains more or less than 2 grms. potassium sulphate per litre, it enables us to determine the proportion to about $\frac{1}{4}$ a gram. per litre: its chief merit is that, unlike the methods at present employed in laboratories, it is within the reach of all.

The process requires ten test-tubes placed in two parallel rows, five in each row; a pipette of 25 c.c., graduated in five divisions, each of 5 c.c.; a burette graduated in five divisions, from 0.5 to 2.5 c.c., each division consequently containing 0.5 c.c.

It being known that 10 c.c. of M. Marty's standard liquid precipitates 0.1 gram. potassium sulphate per litre, we begin by pouring into each of the test-tubes of the first row 5 c.c. of the wine in question. We then add to each of these tubes, by means of the burette, Marty's standard liquid, pouring into the first tube 0.5 c.c., into the second 1.0, and so on till the fifth tube receives 2.5 c.c. The

contents of the five tubes are heated and filtered respectively into the five tubes of the second rank. It is then merely needful to add a drop of the standard liquid to each of the second set of tubes, and to note in which tube it produces a faint turbidity. If, e.g., this turbidity appears in No. 2 and not in No. 3, it appears that the wine contains more than 2 grms. per litre of potassium sulphate and less than 3 grms. Hence it may be concluded that the proportion is about 2.5 grms. per litre.—*Bulletin de la Soc. Chimique de Paris.*

ON THE DETERMINATION OF SULPHUR IN PYRITES.

By F. BÖCKMANN.

THE methods of Lunge and Fresenius have afforded a satisfactorily accurate and expeditious means of determining the sulphur in pyrites. As a third process, which also gives good results, I recommend the following modification of the potassium chlorate method:—Half a gm. of finely ground pyrites (sifting is not absolutely necessary) are mixed in a large platinum capsule with the well-known mixture of 6 parts sodium carbonate and 1 part potassium chlorate. The mixing is effected with a platinum spatula, and is then made more complete by gentle rubbing with an agate pestle fixed to a wooden handle. The whole is then fused over the blast-lamp. The aqueous solution of the melt is first poured into a beaker to avoid spitting, and thence into another tall beaker containing an excess of hydrochloric acid. The filtered solution is heated and precipitated with hot barium chloride, heated gently upon the sand-bath for a time until the liquid standing above the precipitate has become clear, and is filtered at once. The burnt ores in sulphuric acid works have been for a long time assayed for sulphur by this process. I take about 2 grms. of burnt ore to from 20 to 25 grms. of chlorate mixture.—*Zeitschrift für Analyt. Chemie.*

THE SCHOOL OF MINES, BALLARAT.

WE have received the annual report of this establishment presented to the Meeting of Governors, February 9th, 1881, and perceive with pleasure that good progress is being made. The subjects taught, as a matter of course, include mathematics, mining, and land- and engineering-surveying, mechanics and natural philosophy, mechanical engineering, geology, metallurgy, chemistry, mining (both scientific and practical), magnetism, and electricity. We are rather surprised to find materia medica and physiology, botany, and pharmaceutical chemistry among the subjects taught. A proposal made and carried at the Annual Meeting, to open a class for oil-painting, further strikes us as unusual. Some of the professors seem to be, if not overworked, burdened with too great a variety of subjects. Thus Mr. Jos. Flude has to teach metallurgy, assaying, chemistry, botany, and pharmaceutical chemistry. F. M. Krausé, in addition to his important duties as Curator of the Museum, occupies the chairs of mineralogy, geology, electricity, and magnetism. We must express a hope that the Institution will receive such a measure of support as may enable it to introduce a more complete division of labour among its officials.

The museum is evidently improving. Lack of room—a torment from which few curators are exempt—is not absent, and, as the heaps of undetermined and wrongly determined minerals are being labelled and duly classified, the available space is felt to be insufficient. The Curator has arranged the entire collection upon stratigraphical considerations, geographical being subordinated. The heads of the School evidently entertain the bold but most

laudable plan of forming a collection illustrating the geology and mineralogy not merely of the whole of Australia proper, but also of New Zealand and the Fidjis. There are at present 1132 specimens of minerals, and 760 of rocks and fossils.

Turning to the report of the Superintendent of the Laboratories, we find that these are fitted with eighteen work-tables, each duly supplied with gas, water, and apparatus, and affording room for thirty-two students. The Superintendent suggests that a tolerably good spectroscopic should be obtained, and that a special balance room should be provided. The metallurgical laboratory is arranged for twelve students, and is fitted with twelve reduction furnaces, three cupelling furnaces, and a small blast-furnace.

The botanical department is also active. It has formed a collection of about a thousand plants (specimens, or species?), and the Botanical Garden is said to be well kept. Perhaps the physiological studies are arranged with a too preponderating reference to pharmacy.

The Ballarat School of Mines will undoubtedly contribute greatly to the development of the resources of the Australian Colonies.

THE OCCURRENCE OF OPALS IN CENTRAL AUSTRALIA AND QUEENSLAND.*

By JAMES R. M. ROBERTSON, M.D., F.G.S., F.K.G.S.

AT the request of your Secretary, and some of the older members of this society, I have prepared a few remarks upon "The Occurrence of Opal in the Colony of Queensland," and the geological and physical aspects of the country in which they are found.

Very few of those to whom I speak on Queensland are aware that its surface area is about 8½ times that of Great Britain; that 30 years ago there were not more than 1800 white people settled in this vast extent of country; or that at present it can only boast of a population of 217,000, or rather less than one person to every three square miles.

The northern territory of Queensland is mountainous; it is covered by dense tropical vegetation, and is peopled by hostile tribes of aborigines. Of this region, very little indeed of a positive character is known.

The east coast of the Colony is fringed over its whole length by a high mountain chain, for the most part composed of granite. In parts these mountains are highly metalliferous, copper being extensively distributed around Mount Perry and Rawbelle, and at Copperfield; and gold—both alluvial and in quartz reefs—is found over the whole extent of these ranges. The principal gold mining localities are—Gympie in the south, around Mount Perry, Rockampton and Morinish, Charters Towers, and Nebo, inland from Bowen. The Palmer and Hodgkinson districts in the north, while in the mountain ranges that join the east coast with the Gulf of Carpentaria, the Etheridge, Woolgar, and Gilberton gold fields have been opened up. In the far west the Cloncurry copper and gold fields (that I had occasion to visit) exist among the outliers of the M'Kinlay ranges, and from this field the richest ores of copper and the finest gold in all Australia is obtained.

Queensland minerals are all of a high order in respect to quality and productivity; but, up to the present moment, they have not received that attention from capitalists that they deserve. Its quartz reefs carry a higher average of gold than any in Australia; yet, from the rudeness of the manipulative processes, and the perfunctory methods of mining practices, their working has not been attended with the success that better systems

* Paper read before the Glasgow Geological Society and Chemical Section of the Philosophical Society, January 23rd, 1882.

would have insured. I am pleased to be able to make an exception to this general statement in favour of Charters Towers and Gympie, where several complete recovery plants have of late been erected.

The coast ranges rise to an average altitude of 2000 feet. From this elevation, plateaux, or tablelands, extend inland. The granite formation has been pierced by great belts of volcanic or intrusive rocks; and very large areas of these tablelands are covered by slabs of vesicular basalt in process of decay—the decomposition given rise to deep black soils. It is a curious circumstance, that these basaltic blocks are confined to the top, or seem to float upon the surface; the soil underlying them being entirely destitute of stones. Other portions of the plains are composed of chocolate-coloured or red soils, resulting from the decay of intrusive rocks containing iron. Further inland, these black and red soils gives place to extensive Downs, composed of deep, darkish grey soil, overlying rocks, evidently of oolitic or cretaceous age, and exhibiting in parts a peculiar cone-like structure. All these plains are covered by a great variety of the most nourishing and permanent grasses. These plains, over several degrees of latitude and longitude, are perfectly level, and, for the most part, are featureless and destitute of trees, and innocent of roads or tracks. Over them, the traveller rides—often guided by the compass—with no landmarks or mile-stones to relieve the tedium. He looks constantly over an apparently limitless sea of luxuriant grass. In the morning he sees the sun rise out of the grassy sea; he watches it ascend into the blue vault of a cloudless sky, again to set, with gorgeous splendour, to illuminate a similar expanse of verdure.

From the Gulf of Carpentaria, a midrib of hill-ranges run south through the continent. 250 miles south of the Gulf the McKinlay ranges branch off to the east, and from these ranges run south to form the Grey, Coleman, McGregor, and Chiewots, that determine the several watersheds of the interior.

The southern division of Australia, bounding upon Victoria, New South Wales, and South Australia, is more park-like in character than the central division just referred to. A large portion of it is covered by stunted trees or a scrub of peculiar description; its stunted character being due, no doubt, to the uncertainty of the seasons and the protracted droughts to which this part of the colony is subject.

The country is covered by recent rocks, chiefly of soft, friable, unbedded sandstones and indurated clay. It is intersected by low ridges or belts of porphyritic or quartzose rocks. On one of these hard vitreous ridges I noticed a rather curious circumstance. On the very apex of the flinty ridge, with a perfectly arid landscape all around, the savage oatives had dug, at a great expenditure of labour, very possibly with rude stone implements, three small holes, or native wells. In these wells water is at all times found, and they have never been known to overflow. They have possibly been sunk upon some small crack or fissure that exudes water.

The River systems of this part of the colony are peculiar. In the dry season they appear to be composed of connected lines of water holes, known as "Billabongs." During times of drought there are no many reservoirs for the storage of water; but during the rains, they overflow, and are often 20 miles broad. Such are the Maranoa, Warrego, Paroo, Bulloo, Blackwater, and Cooper's Creek River systems.

The stunted scrub that covers large areas of country is called Mulga. Its leaves are small, fleshy, uncotyledonous, and lanceolate, and of a dark olive-green colour. Where the soil is particularly deep and rich, open plains occur, that while moisture remains are covered with abundant and luxuriant grasses. This is the principal cattle rearing district of Southern Queensland, where great mobs of bullocks roam at will "on a thousand hills and bosky dells," living solely on the grasses and nutritious shrubs that abound, until they are collected, and travelled for hundreds of miles, to the Adelaide or Melbourne markets.

The district is subject to droughts. It was near to this that the explorers Burke and Wills, with their party, perished many years ago. When I rode through it in July of last year, not a drop of rain had fallen for over 22 months; and then there was no sign of a change. The grass during such prolonged droughts gets scarce and burnt up, while incalculable quantities are annually consumed by bush fires. At these times cattle enter the Mulga scrub and live, and fatten upon the leaves, travelling once a day, to the nearest waterhole, to slake their thirst; or they feed upon the cotton, or salt bush, that, instead of grass, covers some of the plains.

Very few Marsupials are found in this region; their numbers are probably kept down by the swarms of "diogoes," or native dogs that abound. To cattle these dogs do little damage; but among sheep they cause such destruction that squatters systematically poison them with strychnine. After nightfall the discordant howls of these pests around the camp fires is quite loud enough to awaken anything human, save the easy-minded bushman, who, exhausted by a long ride, has rolled himself in his blanket, and with his head on his saddle has shut his eyes on the twinkling constellations, and with half open mouth is snoring in a manner that speaks volumes for the simple diet of bush life and the invigorating freshness of the air.

The climate is salubrious and healthy. During the summer months of November, December, January, it is hot, but dry, the thermometer averaging 105° to 110° in the shade. The rainy season occurs as a rule in February, when a large part of the country is under water. During March, April, May, the air is cool, the skies clear, the mornings cold, and the surface of the earth covered with flowers and verdure. In June, July, and August, the days are bright and cool, the nights being cold or frosty. September and October are the spring months, when the temperature increases, and showers freshen the parched earth. In the pure atmosphere of these regions there are no febrile ailments, and little disease of any description, save the lesions, and the drivelling idiocy caused by drinking doled rum or a star brandy, at 17/6 per bottle. However excellent the breed of cattle or sheep may be in the colony, there can, I think, be little doubt that its present tendency is to breed a more depraved and demoralised variety of the genus homo.

We had for days been riding through a broad belt of rough and disconsolate scrub, breathing an atmosphere of pulverulent dust; but after crossing the Grey range we enter a broad expanse of green and grassy downs. Breathing the ethereal and invigorating brilliancy of the dry air, our spirits rise, and we strive to forget the rough usage, the forbidding desolation, and the dust of the past week, borne, as we suppose, with exemplary fortitude and Christian forbearance. The silence is profound. As we ride onwards, the feeling increases that, as far as the absence of life or habitation, or occupation is concerned, we might be

"———the first that ever burst
Into that silent sea."

Behind us the higher eminences of the Grey range rise as out of a cloud of gleaming vapour, and these, from their appearance, are known as the *Hay Ricks*. Around us, detached squadrons of Emus, run in uncertain lines; and before us, over a sea of verdure, is the mirage of a great lake. We cross stony ridges, or belts of vitreous and highly transmuted siliceous rocks, over which our unshod horses walk wearily, and once again we cross the grassy plain, bearing almost due west. Water is scarce, some times spaces of 25 miles separate the water holes; in some of these a liquid is seen resembling in colour and consistency thin white paint, and this decoction is imposed upon strangers as water. It tastes strongly of "cow."

We cross salt bush plains, and belts of flaggy sandstones, and at last—above the horizon—the peculiar outline of the ranges, near the locality where he

explorers Burke and Wells perished, rise into view, and lends variety to the scene.

Next morning, we collect our shivering horses by moonlight (the grass and ground being covered with hoar frost, and the pools with ice); and ere the orb of day had arisen, we were thrashing a devious way over frightfully stony ridges; and through thick, prickly scrub, that tear the emblems of our civilisation, and scratches our faces, to emerge from it in a condition of doubtful respectability. We ascend a range composed of gritty sandstone, with slopes, covered with fallen blocks and decaying fragments, piled up in chaotic confusion. Some of the hill masses are of blood-red colour, and exude salts of magnesia. Some are olive coloured, or ochrey yellow. Some resemble Bathstone, and some are a blending of all these. The lithological character of these rocks are by no means distinctive, but they are evidently of tertiary age. Porphyritic dykes traverse, but do not appear to disturb these rocks. High overhead are crumbling cliffs of mottled sandstone of curious outline. Around us the heat quivers in the air, and against their mural sides, the bright sun dances with a fierce delight. By dangerous paths, we continue to ride up the slopes of these fantastic-shaped hills, and, by some unaccountable accident, arrive in safety at the top.

Not a sound (save the panting of our horses) disturbs the solemn and all-prevailing silence. We are alone with nature in the centre of a great continent, and we feel that he, indeed, must possess a dull and incurious mind, who is not impressed by the singularity and the charming loveliness of the scene. Twenty miles off, across a grassy and park-like plain, the Coleman and M'Gregor ranges rise, clear and distinct, amid the flood of light. The outline is wonderfully lovely. In the foreground a number of cone-like and castellated hills, of all colours, rise from the plain; the more connected ranges of the background appearing as if capped by numerous and enormous fortifications. Some of the isolated conical hills terminate in sharp apexes or spikes; others terminate with flat circular crests and perpendicular red sides, rising out of slopes of yellow or reddish earth partially covered by struggling vegetation. The whole of the hills have approximately the same level or elevation. Their contour being entirely due to the effects of climate, operating over incalculable periods of time. I have endeavoured to represent the outline of these hills in sketch No. 1; but I regret that I cannot convey to you any idea of their aspect, as I saw them, through the clear ambient air—rising out of a carpet green, with the sun to illuminate them, and distance to soften, and to heighten the effect.

Similar country, geologically, extends through about 3 parallels of latitude, and about 2 of longitude; and within this area, siliceous minerals, such as quartz in various forms, agates, calcedony, carnelian and opals are found. With the latter only I propose to deal.

These rocks are evidently of Tertiary age; but they possess no very distinct or typical characters. The component parts are gritty sand, or earth. The bedding is obscure, or false; and the colour is apparently due to the admixture of protoxide of iron in varying quantities. The colour is, however, striking; blood red, grey, brick red, cream coloured, olive, yellow, or mottled. These colours may, within a few yards, insensibly blend into one another, or they may be separated by a distinct and sharp line of demarcation, as in the specimen that I now show you.

In certain parts these loosely aggregated sandstones are held together, (as are the great sandstones that overlie the coal formation of N.S.W.), by irregular mahogany coloured ferruginous bands. These segregations of iron have, in some parts of the district, formed fissures within themselves, and into these crevices a fine siliceous fluid has been introduced, and become consolidated. In other localities, where the necessary conditions have been present, these siliceous threads have become opalised; and

where these have absorbed infinitely minute traces of nickel, or manganese, or iron, or all three, they exhibit all the lovely play of colours distinctive of the precious or the fire opal. The specimens will serve to illustrate this condition.

Again, while some of the more aluminous beds have been subjected (we shall suppose) to the influence of heat, the plastic matrix has been rendered vesicular, and a number of the cavities so formed have (by subsequent infiltration) been filled by silica, which has become opalised. Specimens labelled No. 17 simplifies this condition.

Again, as we approached the margins of this district, we passed over certain beds of indurated and transmuted schists, and in these, small nodular concretions of siliceous ironstone can be picked out. These little flattened spheres are about one inch in diameter. On breaking them, numerous minute crevices are seen to radiate from a centre, and these hair-like fissures have been filled by a plastic mass, which has become opalised, but of no value whatever. In the reniform nodules of C. B. ironstone that are found in the clays, or in the soft shale beds of our coal measures identically the same appearances are to be seen; only, in the latter case, the septaria are filled with ordinary quartz.

Approaching the main ranges, almost every other ridge is covered with splinters of a milky, or opaque variety of opal. Specimens Nos. 1 and 5 illustrate this, and the last named variety of opal.

Without going more into detail, I must ask you to believe that it is only within a certain very small area, of this extensive opal-bearing country that opals of any commercial value have been found. I feel that I need scarcely mention that opal is a siliceous mineral—an analysis of precious opal showing 90 per cent of silica and 10 per cent of water. That it is considered an unlucky stone by ignorant and superstitious people; that its beautiful combinations of colours probably depends upon the presence of exceedingly minute proportions of some colouring-matter, such as those produced by iron, nickel, or cobalt—the colour being intensified by the presence of numerous invisible fractures.

I may inform you that over very large tracts of country, in the lower Bulloo, and Barco districts, opal is found filling the narrow and irregular fissures of a ferruginous matrix, or in delicate scales, so thin, that they appear as if painted on to the matrix; but these, however beautiful, cannot be utilised by the lapidary.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, February 25th, 1882.

Professor G. C. FOSTER in the Chair.

New Members:—Prof. G. F. Fitzgerald, Trinity College, Dublin; Mr. C. Richardson; Lieut. H. I. Dockrell, R.N.; Mr. W. Ford Stanley; General H. Hyde, R.E.; Mr. J. Buchanan.

Prof. W. E. AYRTON, F.R.S., read a paper on "Faure's Accumulator," giving the results of experiments made by him and Prof. Perry on the efficiency, storing power, and durability of the battery. The efficiency was got by measuring the power put in and comparing it with that taken out, by means of Perry and Ayrton's voltmeter and ammeter. The authors found that the cell has great resuscitating power if left insulated after all the current appears to have been discharged. Care had to be taken to see that the cell was quite discharged by letting it stand on open circuit for intervals and discharging between whiles. When this was done they found that the total

loss for charges up to one million foot-pounds need not be greater than 18 per cent. With slower charges they got a loss of only 10 per cent. As to the storage, a mean current of 18 Amperes gave after eighteen hours' discharge (six hours on three consecutive days) 1,440,000 foot-pounds of work, equivalent to 1 horse-power in forty-three minutes. The cell contained 8½ lbs. of red-lead, thus making a capacity of about 18,000 foot-pounds per pound of red-lead. The cell showed no deterioration after two months of work.

Prof. AYRTON then described a new form of his Dispersion Photometer, which greatly reduces it in size and convenience. The principle of this instrument has already been described to the Society by the authors. It consists in using a concave lens to disperse the stronger light, and thus obviate the necessity of putting it at a great distance if it is very powerful, such as an electric light. The powers of the two lights are compared by the eye in estimating the intensity of the shadows of a rod thrown on a white screen of blotting-paper by the two lights simultaneously. A sperm candle is used as the standard, and it is placed on a movable stand at an angle to the path of the other beam through the lens. Both the lens and candle can be shifted to and from the screen along a scale giving their distances, and the stronger beam is reflected from a small mirror. This mirror is ingeniously fixed so as to reflect the ray from the same part of its surface whatever angle it is placed at, and thus the power of an electric light can be accurately given for every angle along which the ray travels from the lamp. Observations are taken through red and green glasses to get a better measure of the power of the light. Prof. Ayrton has found that ordinary air absorbs the green rays of the electric light very strongly, and hence, in order to get a proper test of an electric lamp, the photometer should not be far from the light. The new dispersion photometer shown is the only one admitting of this precaution.

Mr. SHOOLBRED stated that he had found from experiment that the carbons of the Swan and Maxim incandescent lamps bore a much higher current without breaking when fed from a Faure accumulator than from a dynamo-electric machine.

Prof. AYRTON corroborated this statement, and said that he had obtained a light of 800 candles from a Maxim lamp fed by an accumulator.

Prof. SYLVANUS THOMPSON then read a paper "On the Electric Resistance of Carbon under Pressure." It was generally stated that the resistance of carbon diminished under pressure, but he had found from recent experiments that the diminution observed was really due to the contact between the electrodes and the carbon. Under pressure there are more points of contact between the metal and carbon than without pressure. The result has an important bearing on the action of the carbon relay, rheostat, and microphone transmitter.

Prof. AYRTON pointed out that as carbon apparently diminished in resistance under a rise of temperature, this would seem to indicate it as a compound substance, since only simple substances seemed to increase in resistance with rise of temperature.

Prof. GUTHRIE recalled that Dr. Moser had suggested that the alteration of the resistance of selenium under light was an effect of contact.

A paper was read by Mr. G. GORE, "On the Influence of the Form of Conductors on Electric Conductive Resistance." His experiments were designed to show whether there was a difference of resistance in certain liquid conductors under the positive and negative current. None was discovered.

Dr. HOPKINSON, F.R.S., read a paper "On the Refractive Index and Specific Inductive Capacity of Transparent Insulating Media." He inferred from tried experiments and the electro-magnetic theory that glass had a high refractive index for rays of very long wave length.

Dr. J. H. GLADSTONE suggested that the point should be tested by experiment, and that the method of photographing the red rays might be employed.

Mr. J. MACFARLANE GRAY explained that an objection to one result of his former communication to the Society on the specific heat of steam was really a confirmation of it, as Regnault's value was erroneous.

CORRESPONDENCE.

SULPHUR IN SHALE NAPHTHA.

To the Editor of the Chemical News.

SIR,—In your abstract of the *Berliner Berichte*, vol. 13, No. 12, there is a note by Kalstadt on the occurrence of sulphur during the dry distillation of coal-tar. I may in this connection be permitted to state that sulphur occurs also during the fractional distillation of shale naphtha.

Shale naphtha is absorbed by means of scrubbers from the gases liberated during the destructive distillation of shale for paraffin oils. The crude product contains a very large quantity of sulphur compounds, chiefly sulphides and sulphuretted hydrogen. This crude product, in the process of refining, is treated with the strongest sulphuric acid, and then with excess of caustic soda, sp. gr. 1.360, after which it is distilled. While the light or more gaseous portions are being distilled over, the sulphur is liberated in greatest quantity, and makes its appearance as minute crystals round the water-lute of the separator. This mode of distillation cannot, however, be said to be dry distillation, inasmuch as the still is urged by steam alone. It is very remarkable that sulphur should separate in this form after the naphtha has been treated as indicated above. The more gaseous portion of the distillate smells strongly of garlic, but affords no indication of sulphur by the ordinary methods of testing for such.

Some time ago I mentioned the occurrence of this sulphur to an eminent chemist, who suggested that it was probably due to a hydrocarbon disulphide, which undergoes decomposition in the process of distillation. This view is perhaps supported by the observation of R. Otto, *Berliner Berichte*, vol. 13, No. 12, that aromatic mercaptans are converted into disulphides by the action of sulphuric acid; and this suggests the question—May not the sulphur compounds present in the crude naphtha be similarly affected by sulphuric acid?

Sulphur is also found in considerable quantities in the drips from the gas mains or condensers from shale retorts; but the production of sulphur in this case is well known and easily understood, viz., the action of sulphites upon sulphides. I think the existence of sulphur in the distillation of coal-tar can be similarly explained. Thus, during the destructive distillation of the coal, sulphuretted hydrogen is liberated in greatest abundance, while the maximum yield of gas is being produced. After the make of gas begins to fall off, the continued action of the exhaustor draws in small quantities of air through the retorts, which burn the sulphur of the pyrites left in the coke, thus forming sulphuric acid, which, on condensation, reacts on the sulphuretted hydrogen with the production of sulphur. This sulphur is dissolved or absorbed by the naphtha, and afterwards eliminated on distilling the tar.

I am, &c,

ROBERT TERTVET, Manager.

Clippens Oil Works, by Johnstone,
February 24, 1882.

A Sulphur Oxychloride.—J. Ogier.—This new compound has been obtained by heating together to 250° in a sealed tube, a mixture of equal weights of sulphur chloride and sulphuryl chloride. It boils at 60° to 61°, and is readily decomposed by heat. It is a deep red liquid of the sp. gr. 1.656. Its vapour-density taken with Meyer's apparatus is given as 3.98, 3.84, 3.75. The author ascribes to it the formula S_2OCl_2 .—*Comptes Rendus*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 7, February 13, 1882.

Double Salts formed by the Haloid Salts of Mercury.—M. Berthelot.—A thermo-chemical study. The author remarks that the complete theory of saline reactions requires a knowledge of the formation of all the compounds capable of existing, i.e., of the simple salts, hydrated and anhydrous, and also of the double salts, the acid and the basic salts, which may be formed either in the moist or the dry way. Their part is especially important in the study of the metallic salts, by reason of their formation-heat and their state of dissociation. If this double property is known, the inverse displacements and the equilibria are a necessary consequence. He has already developed this theory for the acid salts, and he now purposes to enter upon a further application by the examination of the double salts of silver and mercury. For this purpose it was necessary to measure in the first place the formation-heat of an entire group of bodies, comprising the principal double salts, which may take their rise in a given decomposition. The author has done this for the salts of mercury with reference to the derivatives of the four fundamental hydracids, the hydrochloric, hydrobromic, hydriodic, and hydrocyanic.

Researches on the Nitrogenous Acids derived from Acetons.—G. Chancel.—The author's general conclusions are that the acetone of a normal acid gives a nitrogenous derivative, which reducing agents transform into the next lower homologue of the acid generating the acetone. On the contrary, the acetons of isomers of the normal acid pass over several stages. The formation of these nitrogenous acids is a characteristic reaction of the acetons, and renders it possible to distinguish the primary alcohols from the secondary and the tertiary. In certain cases it is capable of giving precise indications on the internal constitution of the acids and the alcohols.

Electric Actions in like Conductive Systems.—M. Deprez.—A mathematical paper, not capable of useful abstraction.

Electric Transfer of Energy to Great Distances.—M. Deprez.—With Gramme machines of the small kind, weighing about 100 kilos., and modified according to the principles which the author has indicated, he has obtained a work of 37 kilogrammetres, the resistance interposed between the motor and the receiver being 786 ohms, representing the distance of 78.6 kilometres of ordinary telegraph wire. This transfer is effected without the appearance of sparks at the brushes, the machine remaining perfectly cold, and without the necessity of taking special precautions for the isolation of the conductors.

Methods of Comparing Coefficients of Induction.—M. Brillouin.—The author concludes that it is easy to construct two coils, such that their mutual induction-coefficient may be calculated with any desired precision. By means of the methods of comparison of which the author has undertaken the study, the special or mutual coefficients of induction of any coils may be determined to within less than 1-2000th.

Generality of the Electro-chemical Method for the Figuration of Electro-chemical Lines.—A. Guéhard.—The author proposes the following law:—If we place at a very small distance from a slender horizontal section of metal exactly fitted to the sides of an electrolytic trough, any assemblage whatever of vertical cylindrical electrodes, the coloured rings which take rise represent with a very close approximation the theoretic system of equipotential lines which would be given by the direct application of

these same electrodes upon a conductive plane taken within the same limits.

Hydrodynamic Experiments: Imitating Electro-magnetic Phenomena by Liquid Currents.—C. Decharme.—Not capable of useful abstraction.

Magnesium Oxychlorides.—G. André.—A thermo-chemical study. The author has obtained and examined the following compounds:—

$MgCl, MgO + 16HO$; $MgCl, MgO + 6HO$;
 $MgCl, 10MgO, 13HO$; $MgCl, 10MgO, 16HO$,
and another compound containing the same relative proportions of magnesium chloride and oxide with 18HO.

Action of Potassium Cyanide upon Potassium Trichloracetate.—E. Bourgoïn.—The author has obtained a crystalline compound, which he has not yet examined.

Formation-Heat of Hydro-ferricyanic Acid.—M. Joannis.—The author adopts the number $+280.5$ cal.

Galactine.—A. Muntz.—The author has isolated this compound from the seed of lucern. It closely resembles the gums, having the composition $C_{12}H_{22}O_{10}$. It is dextrorotatory. It yields much mucic acid on treatment with nitric acid, and yields saccharine matters if boiled with dilute mineral acids. In its physical properties it is identical with the galactose derived from milk sugar. The author suggests that it may be the material whence female herbivorous animals derive the elements for the sugar of the milk secreted.

The Aconitates.—E. Guinochet.—The author gives the preparation, properties, and formulæ of a number of the salts of aconitic acid.

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. December, 1881.

"Denaturation" of Alcohol by the Addition of Wood-Spirit.—Prof. A. W. Hofmann, Drs. Kraemer and Loewenherz.—The authors admit that, in view of the various industrial purposes to which alcohol is applied, no one ingredient can be used in all cases to render it unfit for human consumption. They propose that spirit used in the manufacture of aniline colours should be mixed with 5 per cent of wood-spirit, instead of 10 per cent as heretofore. Alcohol used in making lake-colours for paper-hangings may be mixed with $\frac{1}{2}$ per cent oil of turpentine, and that for mercury fulminate either with the same proportion of oil of turpentine or with 0.025 per cent of animal oil.

January, 1882.

This number contains no chemical matter.

Bulletin de la Société Chimique de Paris.

Tome 36, Nos. 10 and 11, 1881.

A New Apparatus destined to show the Dissociation of Ammoniacal Salts.—D. Tommasi.—This apparatus, the *dissocioscope*, is composed of a glass tube, 20 to 25 centimetres in length, by 3 or 4 centimetres in width. In the interior is suspended, by means of a platinum wire, a slip of blue litmus paper, previously steeped in a solution of ammonium chloride, which has been previously neutralised by the addition of a few drops of ammonia, avoiding excess. A cold saturated solution is required. The slip of litmus paper, after having been withdrawn from the liquid, is slightly pressed between two folds of blotting-paper, and is then suspended in the glass tube while still damp. To use the tube it is simply plunged into boiling water, when the paper at once becomes red. On plunging it again into cold water, it is rendered blue again.

New Method of Determining Gypsum in Wines.—E. Houdard.—Inserted in full.

Constitution of Complex Mineral Acids derived from Tungstic Acid.—D. Klein.—The author considers that in the hypohyphic molecule, $5H_2O, 12WO_3 + xAq$, there appear to be 8 hydroxyls which are only substitutable by bases, and 2 which can be indifferently substituted by basic residues, or by monatomic residues derived from poly-basic acids.

β -Chlorated Allyl-Chloride and some of its Derivatives.—P. van Roinburgh.—Not suitable for abstraction.

Russian Chemical Society.—Session March 5/17, 1881.—M. Eremine examined the effects of the temperature of the voltaic arc upon barium and calcium sulphates. Barium sulphate is volatilised, and calcium sulphate is reduced to sulphide. A quantity of gas is produced, which, if passed into potassa lye, gives potassium nitrate and nitrite, whilst ozone escapes.

M. Boutlerow read a note by M. Gustavson on the transformation of the carbon chlorides into corresponding bromides. Also a new method of preparing solution of aluminium iodide in carbon disulphide.

The Secretary presented, on behalf of M. Kanonnikoff, a memoir on the influence of the structure of organic substances upon their power of refraction.

Also, on behalf of M. Karwowsky, a memoir on the results of the analysis of the excrements of bats, showing the absence of cupric compounds, and the analysis of an abscis extracted from the oviduct of a hen from Kokan.

Also, on behalf of M. Kartchewski, an analysis of mineral waters from Beresow.

M. Boutlerow gave an account of ice at the critical pressure.

M. Lubavine, presented, on behalf of M. Fedoroff, the exposition of a law relative to the values of the atomic weights of the elements. This law is expressed in the form of a table, where the elements are arranged in eight groups, and to each element is appended a number. To pass from these numbers to the approximate values of the atomic weights it is sufficient to raise each number to the 3-2 power, and to multiply the result obtained by 7-8ths. If the homogeneity and the likeness of the elements are admitted, we may conclude that the elements are ranged in the natural system in the increasing arithmetical progression of the surfaces of their atoms, and that the atomicity and the chemical properties of elements may be considered as essential functions of the same surfaces.

Tonice 36, No. 12.

Abnormal Development of Certain Planes in the Crystals of Citric Acid.—M. Ch. Cléiz.—The author gives the figures and measures of certain well-defined crystals deposited from a solution through which a current of chloride had been passed.

On Colloidal Tungstic Acid, and on its Analogy with Paratungstic Acid.—M. D. Klein.—Colloidal tungstic acid is known to possess a great stability, and is only converted into the insoluble acid at a temperature bordering upon dull redness. The author suggests that this colloidal acid may be formed by some unknown tungstic acid, probably the still unexamined paratungstic acid, $12WO_3 \cdot 5H_2O$.

Molecular Compound of Camphor and Aldehyd.—M. P. Cazeneuve.—Camphor shaken up with an aqueous solution of aldehyd, seizes hold of the latter, and is transformed into a liquid which floats upon the surface. The compound is dissociated at ordinary temperatures, leaving a residue of camphor.

Inversion of Sugar by Carbonic Acid.—M. E. Maumené.—M. von Lippmann has obtained 44° with carbonic acid under pressure. M. Maumené was the first to overturn the hypothesis of a division of inverted sugar into equal parts of glucose and chylarose (levulose). Inadose may be obtained by the action of equal weights of normal sugar and silver nitrate, both in concentrated solutions.

Rectification of Alcohols.—M. E. Maumené.—The author combats an assertion of M. Laurent Naudin, concerning his patent No. 86,636.

Determination of the Solid Extract of Wines.—M. E. Maumené.—The author considers that the results obtained by simple evaporation at 100° , are comparable and sufficiently exact for practical purposes.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 2, September and October, 1881.

This number contains no chemical matter save extracts from the *Comptes Rendus*, which have been duly noticed.

MISCELLANEOUS.

Importing Atmospheric Air.—A Berlin newspaper relates an amusing story of the famous German scientist, Alexander von Humboldt, who took advantage of the exemption from duty of the covering of articles free from duty, formerly the rule in France. In the year 1805 he and Gay-Lussac were in Paris engaged in their experiments on the compression of air. The two scientists found themselves in need of a large number of glass tubes. This article was exceedingly dear in France at the time, and the rate of import upon imported glass tubes was something alarming. Humboldt sent an order to Germany for the needed articles, and gave directions that the manufacturer should seal up the tubes at both ends, and put a label upon each tube with the words *Deutsche Luft* ("German air"). The air of Germany was an article upon which there was no duty, and the tubes were passed by the Custom officers without any demand, and arrived free of duty in the hands of the two experimenters.

MEETINGS FOR THE WEEK.

- SATURDAY, 4th.—Physical, 3. "Further Experiments on the Discharge of Electricity by Heat," by Prof. F. Guthrie.
MONDAY, 6th.—London Institution, 5.
— Royal Institution, 5. General Monthly Meeting.
— Medical, 8.30.
— Society of Arts, 8. "Hydraulic Machinery," by Prof. John Perry.
TUESDAY, 7th.—Institute of Civil Engineers, 8.
— Pathological, 8.30.
— Anthropological Institute, 8. "On the Aboriginal Inhabitants of the Andaman Islands," by Mr. E. H. Man.
— Royal Institution, 3. "The Mechanism of the Senses," by Prof. J. G. McKendrick.
WEDNESDAY, 8th.—Society of Arts, 8. "Improvements in Gas Illumination," by Prof. A. Vernon Harcourt, F.R.S.
— Geological, 8.
— Microscopical, 8.
— Medical (Anniversary), 8.30.
THURSDAY, 9th.—Royal, 4.30.
— Royal Institution, 3. "Geographical Distribution of Animals," by Dr. P. L. Sclater.
— London Institution, 7.
— Society of Arts, 8. "Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes," by W. K. Burton.
FRIDAY, 10th.—Royal Institution, 9. "Electric Lighting," by Mr. J. W. Swan, 9.
— Astronomical, 8.
— Querkett Microscopical Club, 8.
SATURDAY, 11th.—Royal Institution, 3. "The Iliad and Odyssey," by W. Watkiss Lloyd.

TO CORRESPONDENTS.

R. Burton.—1. The letters L.S.A. mean Licentiate of the Society of Apothecaries. 2. Your second question had better be addressed to the *Pharmaceutical Journal* or the *Lancet*. 3. It would be exceedingly indiscreet to give an estimate of the relative standing of the medical degrees granted at different colleges.

THE CHEMICAL NEWS

VOL. XLV. No. 1163.

VOLUMETRIC ESTIMATION OF ANTIMONY IN THE PRESENCE OF TIN.

By E. F. HERROUN.

HAVING experienced considerable difficulty in obtaining even approximately accurate results by the usual methods for the analysis of alloys of antimony and tin, I tried the following process, and having found it successful I submit a short description of it to your readers, believing it to be as yet unknown.

This process is applicable to alloys such as Britannia metal or type metal, and depends upon the fact that antimonious chloride is reduced to antimonious chloride by hydriodic acid, with consequent liberation of iodine, whilst stannic chloride is unredacted.

The alloy, in a state of fine division, is dissolved in strong hydrochloric acid with the aid of heat, and with frequent additions of small quantities of potassium chlorate: after the whole of the metal is dissolved a small piece of potassium chlorate is added, to ensure the conversion of the antimonious chloride into antimonious chloride, and the solution gently boiled until all the oxides of chlorine have been expelled. The solution is then allowed to cool, and a slight excess of a strong solution of potassium iodide added. The free iodine is then estimated by means of a standard solution of sodium hyposulphite.

Since 122 parts of antimony liberate 254 parts of iodine, the amount of iodine found multiplied by 0.48031 will give the amount of antimony present.

If iron, or other metal whose perchloride is capable of liberating iodine, be present in the alloy, the tin and antimony may be obtained as oxides by treating the alloy with nitric acid and evaporating, and, after being well washed, may be boiled in strong hydrochloric acid, and the antimony determined as above.

THE ELECTROLYTIC DETERMINATION OF COPPER.

In a paper read by Mr. J. B. Mackintosh, of Hoboken, N. J., before the Virginia meeting of the American Institute of Mining Engineers, he states that he had made a series of experiments with the Luckow electrolytic determination of copper. Mr. Mackintosh describes the manner in which he adapted the Luckow method to the analysis of copper alloys as follows:—

I dissolved the alloy in nitric acid, evaporated the solution to dryness to get rid of the excess of acid, dissolved the residue in water with the addition of a few drops of nitric acid to dissolve the basic nitrate of copper formed, and to this solution added 4 or 5 drops of a concentrated solution of citric acid. This solution was then precipitated in a platinum dish with a current from two Bunsen cells of about one quart capacity. In precipitating several samples at once, I have it arranged so that the whole current traverses the row of dishes, the negative pole of each set being connected with the positive pole of the next succeeding one. In this case, if n be the number of dishes, then $n+1$ is the number of battery-cells of that size used. Some of the results obtained by this method, and on duplicate portions by precipitation from sulphuric acid solution, are as follows:—

| | Sulphuric Acid. | Nitric + Citric Acid. | Error. |
|-------------------|-----------------|-----------------------|--------|
| 1 grm. pig-copper | 98.00 | 99.42 | +1.42 |
| " " | 99.80 | 101.22 | +1.42 |
| " " | 98.92 | 100.41 | +1.49 |
| " " | 98.72 | 100.27 | +1.55 |
| " " | 99.60 | 100.45 | +0.85 |
| 1 grm. brass | 65.83 | 66.93 | +1.10 |
| " " | 65.83 | 66.58 | +0.75 |

In only one case was a smaller percentage obtained by the use of this method; and in that case, the precipitation of the copper was not complete. In many cases, also, in which the amount of error was less than 1 per cent, small quantities of copper escaped precipitation, and were afterward found in the solution.

Mr. Mackintosh has followed up the matter, analysing the copper deposited, in which he determined carbon, hydrogen, and nitrogen; and he reaches the conclusion that some organic matters, and in all probability all, in the presence of nitric acid in the copper solution undergoing electrolysis, cause erroneous results; that from a nitric acid solution, with no organic matter, it is extremely difficult to separate all the copper; and that the old method of electrolysis from the sulphate is the best.

Mr. C. Luckow has taken up the matter in the *Chemiker Zeitung*, in which he states that he added tartaric acid to the nitric solution of copper only with the special purpose of preventing the injurious action of manganese salts when present, with special reference to the assay of the Mansfield copper slates. He states also that the form of the apparatus was designed with that object in view. He advises that tartaric acid be dispensed with, except when small quantities of manganese are present, and says it is easy to deposit the copper from the solution holding free nitric acid, if care be taken to drive off nitrous acid, and not to use too strong a current.—*Engineering and Mining Journal*.

THE OCCURRENCE OF OPALS IN CENTRAL AUSTRALIA AND QUEENSLAND.*

By JAMES R. M. ROBERTSON, M.D., F.G.S., F.R.G.S.

(Concluded from p. 97.)

THE comparatively small area, within which opals of commercial value—that is, in respect to quantity, colour, and thickness—have been found, consists of castellated sandstone hills of curious configuration. I have attempted to delineate in a sketch the physical features of the two hills, under which the best opals have been found. These hills with their mines or openings will hereafter be designated "Aladdin." As in certain localities, minerals occur in certain distinctive forms, so each locality that I have named can at once be distinguished by the characteristic form of its opals.

Instead of the thin, thread-like, or scaly patches that are found in the liver-colored matrix of the Bulloo, or the Barcoo country, it is found in the Aladdin hills in all its most valuable and lovely forms as precious opal, as fire opal (or girasol), as common opal, as wood opal, and as hyaline. At Aladdin, it is found under the following conditions:—

First. Masses of laminated ferruginous silica of some thickness are found embedded among the gritty sandstone beds, and these masses are occasionally divided into squares by comparatively wide fissures. When broken, some of these pieces are found coated with a layer of opal from one-eighth to one-fourth of an inch thick. The opal is arranged in bands of brilliant emerald green, or bluish green, yellow, or red. I show you in Specimens No. 7, two large pieces, coated with opal on three sides, which for beauty can scarcely be surpassed.

* Paper read before the Glasgow Geological Society and Chemical Section of the Philosophical Society, January 23rd, 1882.

Second. In the country immediately adjoining Aladdin Hills large quantities of opaque opal or *calcedony* is found. Nearer Aladdin this variety is found in a more refined and translucent form, showing a little colour, as in specimen No. 2.

The Aladdin opal is found on the slopes of the two hills referred to. These hills rise out of a level, grassy, or scrubby plain. The slopes are composed of loose, decaying pieces of soft sandstone. They have an angle of 45°. The top is a concretionary mass of gritty, loosely aggregated sandstone, full of adventitious or accessory pebbles and minute holes. The colour is reddish or mottled, and is due to the permeation of ferruginous water. The crests are redder than the underlying portions, and resemble badly burnt brick in appearance and consistency. The top of one of the hills is circular, the other is elliptical, and is several hundred feet in length. The crests are divided by vertical joints formed during consolidation, and have broken off by these, forming the perpendicular walls, and produce the castellated appearance referred to. The strata underlying the crests is composed of soft, grey, or yellow earthy layers, closely resembling bath-brick, obscurely bedded, difficult to correlate, broken up by vertical joints, and held together by irregular strings of ferruginous sandstone.

Third. At intervals, soft and somewhat irregular or stragulated beds of steel grey or chalky earth, about eight inches thick, separates these beds; and embedded in this chalky earth, flattened nodules or lenticular masses of what I supposed at first sight were ironstone are found. These nodules are of very uniform size and shape, about 10" x 6" x 5". They are found lying on their flat side. As these nodular masses are the principal source of opals, I would desire to describe them somewhat in detail. (The author exhibited diagrams.) These nodules consist of an external crust or shell, the thickness varying from 1" to 1". This shell is built up of a number of thin concentric layers of ferruginous silica, separated by fine lines of a light yellow colour. On being broken these concentric layers are seen in section to enclose a siliceous, somewhat splintery, cream-coloured kernel that completely fills the shell. These kernels are the *real* matrix of the opal. During the process of drying and consolidation, cracks and cavities have formed, separating parts of the kernel from the shell, but invariably reticulated throughout the mass of the kernel. In the same manner, septaria (fissures and spaces) have formed in the substance of the hard shell, seldom, however, penetrating through all the layers. These vermiform crevices, or septaria, have subsequently become filled with a plastic or gelatinous solution or silica, which has become opal; the quality evidently being dependent on the degree of compression, or the variety and amount of the colouring absorbed, and the presence of other conditions to which I will afterwards allude. I have remarked that the nodules are found lying on one of their flattened sides. Now the thickest and best opals occur as a rule (but not invariably) on the lower surfaces, where from gravity you would suppose a fluid would accumulate. The crevices or septaria occurring in the shell frequently exhibit opal that emits rays of blood-red or emerald-green colour. Where the particles composing the shell have been loosely aggregated, silica has been absorbed, and the substance of the shell itself has become opalised.

The question naturally arises from whence, and in what manner, were these nodules formed? Arranged as the shell is in layers similar to an agate, one is inclined to think that their origin is due to the infiltration of siliceous water into a cavity, but the similarity in form and size, and arrangement in beds, of these nodules oppose certain difficulties. If we adopt this view, we must account for the white kernel within the shells.

If the shells have not been formed within a cavity (and I am inclined to think they have not), they may possibly owe their origin to segregation alone. The kernel is composed of material more compact and siliceous, and

contains less iron than the superincumbent strata. If one could imagine the iron or colouring matter abstracted from that strata while the mass was in solution, the resultant would, I think, present an appearance very much akin to these kernels. As to which of these causes, if any, their origin may be due I am not prepared to say; but I have laid out several forms of these models for your inspection, along with about 110 illustrative specimens, as I took them from the mine, that you may be enabled to form some independent opinion on the subject.

To my mind, the origin of the opal itself is not veiled in so much obscurity. On minute examination, I found that the soft, earthy, superincumbent beds contained curious vertical rod of ferruginous silica, similar to the shells of the nodules. These rods appear to lead from the layers of nodules up through the superincumbent rocks. On breaking one of these rods out, I found that in reality it was a pipe containing, within siliceous walls, a small round channel. I show you such a pipe, No. 13. The first of these that I picked out were either empty or contained a little powdery earth; and I at once recognised in them a clue to the formation of the opal, if not the nodules themselves. While prosecuting my investigations among the shattered fragments of a recently fallen cliff, I came upon additional bits of these fractured pipes, with the channels filled with opal. I have laid out several fragments of these pipes with the channels filled with opal cores (No. 12). One or two of these cores in specimen No. 19 display throughout their whole body the wonderful and delicate play of colours characteristic of the oriental opal. There can, I think, be little room to doubt that the matter that formed the opals in the kernels described was conveyed down through the mass of rock by means of these pipes; but whether these fulfilled the double purpose of conveying down the substance of the nodules themselves as well as the opal, and whether these were synchronous or separated by a period of time must be left for future investigation.

So far as I could discover, there are several layers of these nodules underlying—interstratified, if you will, with sandstone—the Aladdin Hills. These beds or layers are separated from each other, by several vertical feet of strata. The nodules are not all uniformly charged with opal, some are of little value; others contain opal of great value. The most valuable stones are broken by the act of smashing the nodules. As there are no outward signs by which the opal value of the nodules can be determined, each should in future be sawn across in order to discover the quantity and quality of the contained gem. To the right of Diagram No. 3 is an enlarged section of a nodule, shewing the mode in which opal is found within its kernel. The pipe that I have sketched must be considered imaginary, as I have not been able to trace such a clear connection as is here shown. Those of you who know the sequence of the chalk formation will recognise in the occurrence of these nodules a close analogy with the layers of flints found in some districts where chalk is found.

Fourth. I have on more than one occasion remarked that the crests of these hills assumed a castellated or turret form, and were composed of gritty, ferruginous particles of brick-like consistency and colour, and that it was somewhat porous. It has all the appearance of having been subjected to heat, and given passage to heated gases. In examining this sandstone I found the remains of pipes, or vertical channels, with obscurely defined walls, filled with common and precious opal, or opal having a burnt, waxy, vitreous appearance. Opal is found in this sandstone, occupying holes or cavities, or filling up portions of the mass, where the sand has been loosely impacked. Portions of the substance of the sandstone have, in fact, become opalised. You will find specimens in the table illustrating this condition.

In the gritty, brick-like crest, opal is found of beautiful colour, in irregular shoots, among the matrix; or permeating the substance of the matrix.

So far, the result of my investigations go to prove that the origin of opal is due to the infiltration of opal forming material (siliceous waters) from above; and that the subsequent elaboration, or the formative process, has been encouraged under conditions of pressure and heat; both of which I believe to be favourable, if not necessary, for the solution, separation, and ultimate crystallisation of the silica, that in so large a measure forms the opal.

These latter conditions I have not established so fully as I would desire; but this I can say, that the two Aladdin Hills are separated from each other, and are situated between three broad intrusive dykes of compact grey and vitreous *Felsite*; further, that the indurated clays are burnt in places, and bare evidence of having been subjected to a high temperature; that portion of the sandstone bears similar evidence; and that the finest quality of opal is, as a rule, found within a reasonable distance of these "Dykes."

Nor have I been able to determine whether or not the gem exists in like conditions under the level of the surface. There can, however, be no doubt that from all these sources large quantities of opal will be obtained.

Whatever the extent of the resources in depth, or the exact conditions favourable or necessary for the development or formation of the opal, all evidence seems to point to the localisation of these conditions. In other words—that valuable deposits of opal are not widely distributed.

I have stated that the occurrence of these nodular masses inclined me to the belief that their origin was due to segregation; and that it was probable that the opal found in the septaria, or filling the fissures of these nodules, was due to infiltration. I wish you to clearly understand that this is only an opinion; I cannot say that I have established it, even to my own satisfaction. My opinion is based upon finding opal in various forms, within the channels of the vertical pipes, as may be seen in the several specimens laid out for your inspection. It may be held by some of your number that opal, as well as the "casing," or shell of the kernel, have all been formed by segregation; and that the pipes are due to the same cause. Dual segregation in the one case, and the fact that the channel within the pipes are sometimes empty, present to my mind certain difficulties to the acceptance of such a cause. Still, I am not prepared to negative it. It may be permissible to say a few words upon the nature and origin of the material that has (by subsequent agencies) been converted into opal. It is very probable that the material was derived from above, and from the rocks in which it occurs. Opal, as you are no doubt aware, is an amorphous and one of the many forms of quartz. Roughly speaking, it is composed of 92 of silica and 8 of water, with certain colouring agents. You may consider opal as a solidified mass of gelatinous silica, in which the proportion of silica and water varies. You may recollect that when describing the nature and colour of the rocks composing the hill ranges, that I remarked that the surface of the rocks was occasionally coated by an efflorescence of magnesia salts. It is probable that the constituents necessary for the formation of opal may be obtained from the decomposition of the silicate of magnesia by carbonic acid. Causes that would at first sight appear to be trivial and unimportant are often sufficient to cause to pass from one condition to another—from the amorphous to the crystalline state. The presence of carbonate of ammonia would be sufficient (under certain conditions of silica) to precipitate silica and alumina; and ammonia may be produced by the presence of some nitrogenous organic substance in the solution of silica. You are probably all aware that many of the forms of silica do contain organic substance, and this is proved by the change of colour that they undergo when subjected to heat. Chalcedony, rose quartz, carnelian, and smoky topaz, are examples of this condition. Probably the reason why opal is an amorphous and not in a crystalline form (of quartz) is because of the presence in it of iron or manganese.

The amount of water contained in opal varies consider-

ably—from 3 per cent. to 10 per cent. Opal differs from quartz in having a lower specific gravity and an inferior degree of hardness in refraction, and of course in chemical properties. The beautiful combination and play of colours exhibited by opals are probably due to the colouring ingredient present, and these may be influenced by the presence of some invisible flaws. The colours are intensified by heat and light.

Some observers affirm that the distinct bands of some varieties of opals are caused by infusoria, and that the red fire of the noble opal is caused by the presence of minute particles of quartz.

In Hungary and elsewhere where opal is found, the gem is found in trachyte, and is considered as the result of the decomposition of that rock. The presence of siliceous rocks may be considered as essential to the formation of opal, and, like all mineral substances derived from adjoining rocks, it bears a definite relation to the constituents of the rocks, from whence, by decomposition, it was derived.

Dr Dobbie, of this Society, has very kindly furnished me with an analysis of the Opal of Aladdin, of the ferruginous crust of the nodules, of the white matrix or kernel within this crust, of the rock in which these are formed, and these are as follows:—

I. Opal.

| | Per cent. |
|----------------|-----------|
| Water | 6.43 |
| Silica | 93.57 |
| | 100.00 |

II. White Kernel.

| | |
|--------------------------------|--------|
| Sesquioxide of iron | 2.15 |
| Sesquioxide of alumina | 30.94 |
| Silica | 67.31 |
| | 100.40 |

III. Ferruginous crust of Nodule.

| | |
|--------------------------------|--------|
| Silica | 35.89 |
| Sesquioxide of alumina | 2.99 |
| iron | 47.74 |
| Protoxide of iron | 3.55 |
| Lime | 0.46 |
| Magnesia | 0.55 |
| Water | — |
| | 100.00 |

IV. Sandstone of Hill.

| | |
|--------------------------------|--------|
| Silica | 65.94 |
| Sesquioxide of alumina | 13.54 |
| iron | 14.04 |
| Lime | 1.03 |
| Carbonic acid | 0.37 |
| Water | 1.03 |
| Alkalies by difference | 3.88 |
| | 100.00 |

In the flats immediately surrounding these remarkable hills are several circular mounds, evidently marking the site of other conical hills, slowly settling down, under the influence of the climate; the earthy portion has all been washed away into the plains; the ferruginous nodules have been broken up by the powerful rays of the sun, the rains, and the winter frosts. Amid the wreck of material one has no difficulty in picking up pieces of opal weathered by the sun-rays of a thousand summers; and bushels of matrix, or shells, may be gathered with the substance a network of brilliant green threads of opal, which when cut and polished might be utilised as buttons, or breastpins, or for inlaying, or in other useful ways.

I have taken up much of your time, and probably have succeeded in exhausting as much of your patience, in describing

the details of the occurrence of opal in Central Australia. My apology for so doing rests in the circumstance that I have not been able to discover any work in which the occurrence of these gems are minutely described. Dana states that in Hungary, Bohemia, Saxony, Mexico, Iceland, opals are found, and that in these countries they are "found filling the cavities or the seams of igneous rocks, or (like other quartz concretions) embedded in flint and limestone." The description is certainly vague, and he might have added Brazil, were it occurs in connection with transmuted limestone, or in crevices of altered chalk. So far as I can discover, Australian opals will in the future be more heard of. They occur under totally different conditions to those he alludes to, and to all appearance in quantities that should the gem become as popular as from the beauty of its hues it deserves, these lonely wilds of Central Australia will be the scene of an industry, as lucrative as it is novel.

The recollection of the magnificent view from the top of the Aladdin hills comes back as a green and pleasant reminiscence of a long and wearisome journey. Though there is no soil on the top, a few stunted honeysuckles and hardy flowering plants have struggled into existence to "waste their fragrance on the desert air." Among these we sit to scan the illimitable landscape and to watch the sun set in an atmosphere of roseate glory. We see the light stealing over the plain, colouring the scrub and illuminating the curiously shaped hills with golden hues. It vanishes from the plains, to play among the lesser hills; wonderful effects of light and shade are visible. Mounting upwards, bands of coloured rays are projected against the crests of the higher peaks that shine for a moment like burnished gold. While yet the soft and short twilight of these regions lingers on the mountain slopes, and the valleys are in partial darkness, we seek the genial warmth of the camp fires and the comfort of the "cup that cheers, but not inebriates," and rolled up in our blankets, we fall asleep under—may I say—the shadow of the Southern cross. At an early hour we had turned our back on these quiet and sunny scenes, and with our saddle bags heavily laden with the spoils of the Aladdin hills we jog steadily back on our long journey of well nigh a thousand miles towards Brisbane and the rising sun, meditating all the while on a further journey of 13,000 miles through the land of the "Spread Eagle" towards home and friends. I did not at that time anticipate that I should so soon after my arrival have the felicity of appearing before the members of this society, to dilate (as I have done) at no considerable length, on the physical geography of part of "Greater Britain"—the land of the Wallaby and the Kangaroo—and the geological aspects of the opal country of Central Australia.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 2, 1882.

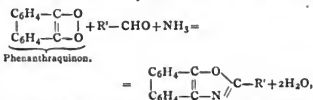
Prof. H. E. Roscoe, President, in the Chair.

The following certificates were read for the first time:—J. H. Eckett, E. G. Love, A. M. Palmer, W. H. A. Peake, J. Robinson, and J. H. Stebbins.

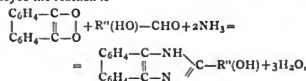
The following gentlemen were elected Auditors for the year:—Messrs. D. Howard, A. J. Greenaway, and D. L. T. Thorne.

The President then called on Dr. JAPP to read a paper "On the Action of Aldehyds on Phenanthraquin in presence of Ammonia" (Third Notice), by F. R. JAPP and F. W. STRATFIELD. In a previous paper it was mentioned that by the action of salicyl-aldehyd and ammonia on phenanthraquin a compound, $C_{21}H_{14}N_2O$, was obtained. The present paper is devoted to a further study

of compounds obtained by acting upon phenanthraquin in the presence of ammonia with hydroxy-aldehyds and with a methoxy-aldehyd. The properties and reactions of the various compounds obtained are given in detail in the paper. The general results may be summed up as follows:—The reaction varies with the nature of the aldehyd employed. 1. With aldehyds of the benzene series the reaction takes place thus:—



in which R' represents a monad radical of the phenyl series. Furfur-aldehyd acts also like an aldehyd of the benzene series. The compounds formed belong to the class of substances which were obtained by Ladenburg (*Ber.*, ix., 1524), in which a triad radicle, of the form $\text{R}'-\text{C}\equiv\text{C}$, replaces the three atoms of hydrogen in the amidogen and hydroxyl groups of ortho-amido-phenol. 2. When hydroxy-aldehyds of the benzene series are employed the reaction is—



the compound formed belonging to the class of the anhydro-bases described by Hübnér. 3. With a methoxy-aldehyd (the reaction of the methyl ether of salicyl-aldehyd has alone been studied) both the above reactions take place simultaneously, and a mixture of the two compounds above mentioned is accordingly obtained. The above reactions, which may be regarded as condensations in the ortho-series, are most readily accounted for on the assumption that phenanthraquin possesses the peroxide constitution ascribed to it by Graebe. The actions of ammoniac formate upon phenanthraquin, and of acetone and ammonia upon phenanthraquin, are being investigated.

Dr. JAPP then read a second paper, "On the Application of the Aldehyd and Ammonia Reaction in determining the Constitution of Quinons," by F. R. JAPP and F. W. STRATFIELD. As the reaction described in the previous paper probably belongs to the class of condensations in the ortho-series, it ought not to occur with paraquinons, and may therefore be used as a test of the ortho-position in quinon. Chrysoquinon and β -naphthaquinon were thus noted. Chrysoquinon proved to be an orthoquinon; the second body yielded only a negative result.

Mr. R. COWPER then read a paper "On the Solubility of Glass in Certain Reagents." Ammonium sulphide was the first reagent, the action of which was investigated: 100 c.c. of the ammonia, sp. gr. 0.880, from which the ammonium sulphide was prepared in the usual way, left 0.0015 grm. residue. The other reagent was ammonium hydrate. A measured quantity of the reagent was sealed up in a tube of hard Bohemian glass, and kept at 100° C. for six days. The liquid was then poured out, neutralised with HCl, evaporated, and the residue ignited. The following table gives the results obtained:—

| Reagent. | M.grms. dissolved by 100 c.c. | |
|---|-------------------------------|------|
| H ₂ O | 8.0 | 10.0 |
| H ₂ S | 12.5 | 8.7 |
| Dilute Am ₂ S (from AmHO 0.982) .. | 49.6 | 52.5 |
| Strong Am ₂ S (from AmHO 0.880) .. | 34.0 | 47.2 |
| Dilute AmHO 0.982 | 25.8 | 42.5 |
| Strong AmHO 0.880 | 7.5 | 7.7 |
| AmHS (from AmHO 0.982) | — | 51.2 |

It will be seen that the dilute solution of AmHO and Am₂S have a very marked solvent action on glass.

Mr. R. COWPER then read a second paper, "On the Analysis of a Piece of Oxidised Iron from the Condenser of H.M.S. Spartan." The specimen consisted of a brownish substance, with many shining black particles, and resembled a piece of rusty grey pig-iron. Its sp. gr. was 2.63; it was very friable. Details are given of the quantitative analysis, which yielded the following result:—

| | | | | |
|-------------------|-------------|-------|--------------------------------|-------|
| | Carbon .. | 12.57 | | |
| | Hydrogen .. | 0.24 | | |
| Insoluble residue | 31.84 | | SiO ₂ | 16.98 |
| | | | Fe ₂ O ₃ | 0.12 |
| | | | Al ₂ O ₃ | 0.06 |
| | | | CaO | 0.015 |
| | | | MgO | 0.02 |
| Cupric oxide .. | 0.38 | | | |
| Ferric oxide .. | 2.21 | | | |
| Ferrous oxide .. | 42.33 | | | |
| Alumina .. | 0.16 | | | |
| Manganic oxide | 1.02 | | | |
| Cobalt oxide .. | 0.05 | | | |
| Sodium oxide .. | 0.11 | | | |
| Phosphoric acid | 5.24 | | | |
| Sulphuric acid.. | 0.31 | | | |
| Chlorine .. | 2.08 | | | |
| Vanadic acid .. | 0.11 | | | |
| Water .. | 16.71 | | | |

102.55

The points of interest, are that there was not a trace of metallic iron, a great preponderance of ferrous over ferric oxide, and a comparatively large proportion of chlorine in combination with iron and manganese. Ordinary cast-iron rust contained 65.4 per cent Fe₂O₃ and 7.42 per cent FeO. A somewhat similar preponderance of FeO is given in an analysis of oxidised iron from the blade of a screw-propeller, by Liversidge (*Proc. R. S. of New S. Wales*).

The PRESIDENT believed that a somewhat similar oxidation of iron was mentioned in Percy's "Metallurgy," in the case of an iron pump at the bottom of a coal-pit.

Dr. DENUS mentioned the conditions under which the oxidation had taken place: the iron formed part of a box through which ran a copper pipe. He then recapitulated the points of interest in the paper, and especially drew attention to the large amount of ferrous oxide.

Dr. DUPRE suggested that the rapid oxidation was caused by a galvanic action of the iron and copper, rather than by the rusting of iron in sea-water.

Dr. DENUS disagreed entirely with the suggestion of the last speaker.

The SECRETARY then read a communication "On the Action of Sodium Hydrate and Carbonate on Felspars and Wollastonite," by W. FLIGHT. The author has made many quantitative experiments on this subject. Thus a specimen of Adularia felspar was dried at 120°, and digested, with about 31 times its weight of sodium hydrate in strong solution, for twenty-five hours, at 100°, in a platinum vessel; 35.688 per cent of the Adularia was rendered soluble. The general result at which he arrives is that sodium hydrate acts powerfully as a solvent upon these silicates, but that the strongest sodium carbonate has but a slight action. The author also proves that the action of sodium hydrate is simply that of a solvent.

The SECRETARY read a second paper by Dr. FLIGHT, "On the Preparation of Pure Nitrogen." The author was quite unable to remove the last traces of oxygen from atmospheric air, either with phosphorus, potassium pyro-gallate, hyposulphites, an alloy of 2 parts of potassium and 1 part of sodium or metallic copper at a red-heat. In all cases the nitrogen contained oxygen, and developed a brown colour in potassium pyro-gallate. He was able, however, to remove the oxygen completely by passing the gas over a large surface of ferrous hydrate freshly precipitated, by adding a strong solution of 80 grms. of caustic potash, to a solution of 200 grms. of ferrous sulphate.

Mr. W. H. PARRIN then read a paper entitled "Some

Observations on the Luminous Incomplete Combustion of Ether and other Organic Substances." The author observed, when evaporating ether in a shallow vessel on a strongly heated sand-bath, on a dark evening, that a pale blue flame was floating about the surface of the sand. On referring to Gmelin's Handbook he found that this phenomenon had been observed by Sir H. Davy. Döbereiner and Boutigny have also put on record similar observations. In the present paper the author has pursued the investigation somewhat further, in order to produce the effect on a sufficiently large scale for lecture purposes. It can be shown by directing a jet of ether (preferably containing from 5 to 10 per cent of alcohol) from a wash-bottle on to a thick iron dish heated nearly to dull redness. Ether enters into this luminous incomplete combustion about 260° C., much irritating vapour being produced: the temperature of the flame is so low that it does not char paper or inflame carbon disulphide. If the flame be confined, as by a paper chimney, the temperature soon rises, and the ether enters into ordinary combustion. Another very effective method of exhibiting this blue flame is to suspend an iron ball, heated nearly to a dull red-heat, over a dish containing filter paper moistened with ether, when a lambent blue flame surrounds the ball. In all cases a dark room is necessary. Spermaceti thrown on to a heated iron ball gives a similar result. Olive oil, linseed oil, white wax, paraffin, stearic acid, oleic acid, and acetic aldehyde gave blue flames when heated. Methyl and ethyl alcohols and propionic acid also gave a feeble reaction. Benzene, toluene, naphthalin, anthracen, formic acid, acetic acid, benzoic acid, cinnamic acid, and phthalic acid gave no result. The phenomenon is probably analogous to that observed at ordinary temperatures with phosphorus. The author demonstrated with complete success the blue flame obtained as above described with ether and spermaceti.

The Society then adjourned to March 16th, when the following paper will be read:—"On Valency," by Dr. Armstrong. The undermentioned papers are also announced:—"On Pentathionic Acid," by Watson Smith and T. Takamatsu; "On some Constituents of Resin Spirit," by G. H. Morris; "On the Preparation of Di-ethyl-naphthylamin, and on the Action of Sulphuric Acid on that Substance," by B. Smith.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, January 26, 1882.

Mr. I. LOWTHIAN BELL, F.R.S., Vice-President, in the Chair.

THE minutes of last meeting were read and confirmed.

Dr. H. S. Pattinson was elected a member of the Society. The following nominations were made:—Mr. J. R. Young, Dr. Rudolph Messel, Mr. A. J. Smith, Mr. C. E. Stuart, B.Sc.

"Experiments with Alloys of Lead, Copper, and Antimony, to Determine their Value and Fitness in the Erection of Sulphuric Acid Chambers," by JOHN GLOVER.

From time to time there has appeared, both in foreign and English publications, an account of experiments on the action of sulphuric acid on alloys of lead and antimony.

The results of such experiments, I believe, showed that a small percentage of antimony lessened the destructive action of the acids.

A small percentage of copper, when alloyed with lead, was also said to have a similar effect.

As all the experiments, so far as I am aware, were made by heating the acid and the alloy together, and noticing the loss, it occurred to me that any inference drawn from such experiment as to the benefits to be derived from the use of such alloys in the construction of sulphuric acid chambers might be misleading, seeing that the

chemical conditions and consequent reactions are very different in a chamber from those existing in a concentrating pan. To test this idea, Mr. Norman Cookson, one of our members, very kindly prepared the alloys used in the following experiments, and rolled them into sheets of about 7 lbs. per foot in his excellent rolling mills, under the same conditions as sheet lead is generally rolled.

Portions of these sheets, of such sizes as permitted their being weighed on a balance turning with 1-50th of a grain, were hung in a chamber, being the first in a series, at a distance of 30 feet from the inlet, 1 foot 6 inches from the top, equidistant from the sides, and within a few inches of each other.

The chamber was worked in all respects as chambers are usually worked when Spanish pyrites and towers are used. The samples were all put into the chamber together on September 22, 1880, and taken out together on January 10, 1881, a period of 170 days.

The line marked A in the accompanying table shows the effect on a piece of sheet lead made with the same lead as that used in the alloys, and exposed to exactly the same conditions as to time, place, and chemical action.

| A Unalloyed Lead, 7½ per cent Loss. | | Alloy of Copper. | | Alloy of Antimony. | |
|-------------------------------------|----------------|---------------------|----------------|-----------------------|----------------|
| Per cent of Copper. | Loss Per cent. | Per cent of Copper. | Loss Per cent. | Per cent of Antimony. | Loss Per cent. |
| 0.1 | 7.1 | 0.1 | 8.1 | 0.1 | 8.1 |
| 0.2 | 7.1 | 0.2 | 9.2 | 0.2 | 9.2 |
| 0.3 | 7.5 | 0.3 | 10.9 | 0.3 | 10.9 |
| 0.4 | 8.1 | 0.4 | 11.6 | 0.4 | 11.6 |
| 0.5 | 8.5 | 0.5 | 11.9 | 0.5 | 11.9 |
| 0.75 | 8.7 | — | — | — | — |

The percentage amounts of copper and antimony were determined by synthesis, pure antimony being used. Mr. Cookson had some difficulty in making the alloy with copper, which may account for some discrepancy in that column. The inference deducible from these experiments is that such alloys are not to be recommended for sulphuric acid chambers.

Mr. COOKSON—In reference to Mr. Glover's paper, I should like to point out that there is a very wide difference between acid conditions and chamber conditions. Knowing that Mr. Glover was going to bring the results of his experiments before the Society to-night, I thought it might be interesting to add to his remarks some results which have been obtained by Mr. Sanderson and myself in regard to alloys of lead and antimony. Mr. Glover's experiments were carried out under chamber conditions, ours under acid conditions. We took commercially pure lead, and alloys of the same lead with 0.1, 0.3, 0.5, and 1.0 per cent of antimony, and heated them for different periods in acids of different strengths, determining in each case the loss which the plate sustained. The samples were all as nearly the same size as possible, the difference in weight being caused by the unavoidable slight difference in thickness. The surfaces presented were identical. The table below shows the result.

It will be seen that in the strong acid the effect of the antimony is very bad; with the weaker acid it is not very perceptible. For my own part, I think the standing of the lead is to a great extent a physical question, and depends on the condition of the lead rather than its composition. A short time ago we sent some lead to a manu-

facturer, who used it for concentrating pans, and he complained that after a very few hours' use the lead was nearly half eaten away. On examining the lead we found that it had gone in lines parallel to the direction of rolling. Analysis showed it to be commercially pure lead. We then took plates of this lead, and of another lead which was said to have stood excellently in the concentrating pans, rolled them under the same conditions, and sent them to Mr. Glover without telling him their history, and asked him to hang them in his chambers with his other plates. A similar pair was hung in our own chambers; in both cases the lead which had been complained of for concentrating pans stood very much the best.

Mr. JOHN PATTINSON—It appears from the experiments, both of Mr. Glover and Mr. Cookson, that no advantage, from a chemical point of view, is derived by the addition of antimony to lead. I should like to ask whether it is beneficial in any other respect—in increasing the mechanical strength of the lead, for instance?

Mr. COOKSON—The alloys with antimony are harder, and will bear a greater tensile stress than pure lead; for instance, they are extremely useful for the vessels from which the acid is forced up to the Glover towers.

The CHAIRMAN—It seems that pure lead is still the most suitable material for chambers, and that the addition of antimony does not at all improve it for that purpose. I should just like to suggest, with regard to the small irregularities in the action of acid on copper-lead alloys, as shown in Mr. Glover's table, that possibly the samples from which the analyses were made might not be altogether fair representations of the composition of the plates. We know that in the case of many alloys a re-distribution goes on during cooling before solidification, which causes different portions of the mass to vary slightly in composition, and it is possible that this may be the case with these alloys.

"On the 'Albo-Carbon Light,'" by JOHN PATTINSON, F.I.C., F.C.S.

The "Albo-carbon Light" is the name given to the light produced by the burning of ordinary lighting gas enriched by the vapour of naphthalen. Naphthalen ($C_{10}H_8$) is obtained by the distillation of the heavy oils from coal-tar. At ordinary temperatures it is solid, and when quite pure it is white, but, as usually obtained for use in the "Albo-carbon" lamp, it is of a brownish white colour. It melts when heated to about 174° F., and boils at about 420° F. It probably exists in small quantities in all ordinary coal-gas, and occasionally causes a good deal of trouble, especially in cold weather, by condensing in the gas-pipes and preventing the free passage of gas. In the "Albo-carbon" apparatus the naphthalen is placed in a spherical vessel to which a tongue of copper is attached which projects over the flame and conveys heat to the spherical vessel and its contents. The naphthalen is thus melted and vapourised. The ordinary gas is led into the spherical vessel, through which it passes on its way to the burner, carrying with it the naphthalen vapour. The lamps are made of various patterns, and have one, two, four, six, or eight burners. They are the invention of Messrs. Kidd. The "Albo-carbon Light" was exhibited at the Newcastle Meeting of the British Association of Gas Managers in 1879, but since that time it has been much improved.

I have recently had occasion to examine one of the new "Albo-carbon" lamps for Messrs. Bainbridge and Co., of

| | Four Hours' Boiling in Strong Acid. | | Eight Hours in Acid. | | Twelve Hours in Acid. | | Sixty Hours in Acid. | |
|------------------------------------|-------------------------------------|------------|----------------------|------------|-----------------------|------------|----------------------|------------|
| | Weight. Grs. | Loss. Grs. | Weight. Grs. | Loss. Grs. | Weight. Grs. | Loss. Grs. | Weight. Grs. | Loss. Grs. |
| Lead from which mixtures were made | 338.06 | 14.526 | 322.874 | 6.164 | 323.376 | 0.502 | 323.534 | 0.158 |
| Containing 0.1 per cent antimony | 389.58 | 17.542 | 371.45 | 8.23 | 371.93 | 0.48 | 372.038 | 0.108 |
| " 0.3 " | 40.33 | 24.052 | 385.572 | 14.072 | 386.132 | 0.56 | 386.278 | 0.146 |
| " 0.5 " | 419.73 | 34.68 | 384.512 | 25.822 | 384.99 | 0.478 | 385.05 | 0.06 |
| " 1.0 " | 441.538 | 39.758 | 401.22 | 29.632 | 01.704 | 0.484 | 401.78 | 0.076 |

Newcastle, and through their courtesy I am enabled to make known the results I have obtained. As the "Albo-carbon Light" is coming into use in several places in Newcastle and elsewhere, I have thought that these results would be of interest to many of the members of this Society.

The form of lamp experimented with was one with a single burner. The burners used in all the lamps are small union-jet burners (Bray's No. 1), altogether unsuitable for burning common coal-gas, but found to be most suitable to burn the enriched gas.

In order to determine the quantities of gas and naphthalen used per hour when the maximum amount of light was yielded that the burner was capable of giving without causing a smoky flame, the lamp was first weighed after it was heated, and when the vapour of naphthalen was coming off freely; the flame was then allowed to burn for one hour, during which time ten determinations of the illuminating power were taken at regular intervals; the lamp was then again weighed, and the difference between the two weighings gave the amount of naphthalen used in one hour. The amount of gas used at the same time was carefully measured by a meter.

It was thus found that the average light yielded during the hour was equal to 24 standard sperm candles, and that this was produced by the consumption of 3.7 cubic feet of common coal-gas of 16 candle-power and 120 grs. of naphthalen, or "Albo-carbon," as it is called.

Calculating these results to the usual standard of 5 cubic feet, the illuminating power of the ordinary gas is thus raised so as to produce a light equal to 32.41 sperm candles per 5 cubic feet of gas used, or to the illuminating power of very good canal coal-gas.

Let us now consider how much common gas alone would be required to yield the same amount of light. This depends in a great measure on the kind of burner used. Many flat-flame burners in very common use will not yield more than 10 candles' light when burning at the rate of 5 cubic feet per hour. Other flat-flame burners when using larger quantities of gas per hour will yield a light equal to about 17 candles per 5 cubic feet of gas, whilst in good argand burners a light equal to 18 or 20 candles per 5 feet of gas used can be obtained. For the sake of comparison, however, let us assume that the ordinary gas is consumed in flat-flame burners which yield a light equal to 12 candles per 5 cubic feet, and this will not be far from the average yield of the gas when fairly good flat-flame burners are used. Two such burners would be required to yield a light equal to 24 candles, and they would consume together 10 cubic feet of gas per hour.

The price of gas in Newcastle, after deducting the usual discount for cash, is at present 2s. 0½d. per 1000 cubic feet. The price of "Albo-carbon" is 6d. per lb., or, when sold in large quantities, 40s. per cwt.

Taking these data it will be found that in order to enrich with "Albo-carbon" 1000 cubic feet of gas so as to produce a light equal to 24 candles when burnt at the above-named rate, 4.63 lbs. of "Albo-carbon" will be required. The cost of 1000 feet of enriched gas, taking "Albo-carbon" at 6d. per lb., is as follows:—

| | |
|------------------------------------|-------|
| 1000 feet of gas | s. d. |
| 4.63 lbs. of "Albo-carbon" | 2 0½ |
| | 4 4 |

Taking "Albo-carbon" at 40s. per cwt., the cost is as follows:—

| | |
|------------------------------------|-------|
| 1000 feet of gas | s. d. |
| 4.63 lbs. of "Albo-carbon" | 2 0½ |
| | 1 7½ |
| | 3 8 |

These quantities would give a light equal to 24 candles for 270 hours.

In order to produce the same amount of light for the same length of time from ordinary gas when fairly good

flat-flame burners are used giving 12 candles' light per 5 feet of gas as above-mentioned, 2700 cubic feet of gas would be required, the total cost of which is 5s. 5½d.; or 1s. 1½d. more than the "Albo-carbonised" gas if the cost of the "Albo-carbon" is 6d. per lb., and 1s. 7½d. more if the "Albo-carbon" has cost 40s. per cwt.; or a saving of about 20 per cent in one case and 30 per cent in the other.

If the ordinary gas is used in argand burners of good construction, the comparison as regards cost is not so favourable to the "Albo-carbon" light. Such a burner will give a light equal to 18 candles per 5 feet of gas used. In order, therefore, to produce a light equal to 24 candles for 270 hours, 1780 cubic feet of gas would be required, and the cost of this is 3s. 7½d., or 9d. less than the "Albo-carbonised" gas when the "Albo-carbon" has been bought at 6d. per lb., and one penny less if it has been bought at 40s. per cwt.

There are many objections to the use of argand burners, many of them on the score of their requiring more care and attention to keep them in good order; at any rate it is found in practice that flat-flame burners, consuming about 5 feet per hour, are chiefly used for general household purposes, and the comparison between the latter and the "Albo-carbon" light is therefore, for practical purposes, of more use in determining the relative value of the two modes of lighting.

The cost of an equal amount of light from the enriched gas is not only less than when ordinary gas is used in 5 feet flat-flame burners, but there is less vitiation of the air by the products of combustion. I find that in burning one cubic foot of enriched gas 0.70 of a cubic foot of carbonic acid gas is formed, whilst from the 2.70 cubic feet of gas alone, required to yield an equal amount of light, 1.51 cubic feet of carbonic acid is formed, or more than twice as much. Again, as regards sulphur, Newcastle gas usually contains about 0.01 grain per cubic foot. Naphthalen contains none. Seeing that nearly two-and-three-quarter times as much gas alone is required to produce an equal amount of light as when "Albo-carbon" is used, and that "Albo-carbon" contains no sulphur, there is nearly two-and-three-quarter times as much sulphur passing into the air of the room as sulphurous acid when the same amount of light is produced from gas alone as when "Albo-carbon" is used.

As regards the heat produced by the combustion in each case, I calculate that one cubic foot of the enriched gas will develop 745 British heat units, and that the 2.70 cubic feet of gas alone, required to produce the same amount of light, will develop 1869 heat units, or about two-and-a-half times as much heat.

In warm weather this additional heat is sometimes objectionable. In winter, however, the living rooms of our houses are made pleasantly warm by the heat arising from the burning gas. It is the carbonic and sulphurous acids with which the heat is accompanied which sometimes cause the air of such rooms to become unpleasant and oppressive. If these gases could be removed the heat would not be objectionable.

From what has been already stated it will be seen that the "Albo-carbon" light has many advantages over common gas alone. It must not be assumed, however, that it has no disadvantages. The following may be placed in this category:—

1. The lamp, at any rate as applied to ordinary brackets and chandeliers, is somewhat ugly in form, and throws an unpleasant shadow. The requirements of the case do not lend themselves readily to an artistic and elegant form. The larger lamps with six or eight burners, and with the naphthalen reservoirs below the burners, are the most elegant in form.

2. There is the labour and inconvenience of replenishing the spherical vessels with fresh "Albo-carbon" from time to time. The single-burner lamps are expected to burn for about 24 hours when fully charged with "Albo-carbon." The process of re-charging will probably have to be undertaken about twice per week. This I expect will be found

a troublesome and irksome process as compared with the readiness and convenience of ordinary gas.

3. In order to heat the apparatus and the "Albo-carbon," so that the vapour of the latter is formed in sufficient quantity to develop much light, the gas alone has to be burned for some time after it is first lighted, and as it is necessary to use a form of burner which is not suitable for developing light from common coal-gas, a very inferior light is produced during this process of heating. In my experiments the amount of light from the gas burning at the rate of 4.1 cubic feet per hour under a pressure of 1.2 inches was only equal to 2.4 candles when the gas was first lighted. In half an hour the light was considerably improved, but it was not until an hour had elapsed that the light became equal to 24 candles. This objection may be got over by lighting the gas half an hour or an hour before it is wanted, but this incurs additional expense and trouble.

4. Should the apparatus containing the naphthalen become overheated, more of the naphthalen is vapourised than can be properly consumed, and the flame gives off smoke accompanied with a disagreeable smell. When this occurs the amount of naphthalen vapour passing to the burner can certainly be regulated by turning a two-way tap in the lamp; but this requires care and attention, and much injury may be done to the furnishings and decorations of rooms should it be neglected.

There is no doubt that the "Albo-carbon" apparatus greatly enriches ordinary coal-gas and causes it to yield a beautiful white light at a cost less than the same amount of light can be obtained for from ordinary gas burnt alone in ordinary flat-flame burners. In the hands of careful people who choose to take the necessary trouble about it this form of light will be used with considerable advantage; but whether the extra care and attention it demands will, as in the case of the argand burner, prevent its being largely used in the place of the more convenient, although inferior, ordinary gas burnt in flat-flame burners; or whether both these modes of lighting will be ultimately superseded to a great extent by the more beautiful and purer light of the incandescent electric lamp of our President, or by some other form of electric lighting, time will reveal.

The thanks of the meeting were then given to Mr. Glover and Mr. Pattinson for their papers.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

January 23, 1882.

MR. ROBERT R. TATLOCK, President, in the Chair.

DR. JAMES R. M. ROBERTSON read a paper on "*The Occurrence of Opals in Central Australia and Queensland*," and showed a large number of very fine opal specimens. (See pp. 95 and 101.)

An interesting discussion followed, in which Mr. Young, Dr. Dobbie, Mr. Glen, Mr. Kirsop, Mr. Mayer, and Mr. Whitelaw took part.

A hearty vote of thanks was then accorded Dr. Robertson.

Hydrodynamic Experiments, affording an Imitation of the Phenomena of Electro-magnetism and Induction by means of Liquid Currents.—C. Decharme.—The author remarks that M. Bjerkes in his hydrodynamic experiments by means of bodies pulsating or vibrating in water, imitating the phenomena of static electricity and magnetism, has found everywhere an inverse analogy. M. Decharme in his experiments with liquid currents finds a direct analogy between hydrodynamic phenomena and those of electro-magnetism and induction. — *Comptes Rendus*.

OBITUARY.

PROFESSOR A. FREIRE MARRECO, M.A., F.C.S.

THE death of Professor A. Freire Marreco has created a conspicuous blank in the scientific world and in the higher circles of Newcastle society. The deceased gentleman was much and deservedly esteemed by all with whom he exchanged the courtesies of private life, and by whom his loss is mourned as that of a dear personal friend. His superior scientific attainments and extensive knowledge in the direction of literature and art, rendered him at home on most subjects, but the charm of his conversation lay in his refreshing originality and humour, and this, with his ready command of language, constituted him a conversationalist of the most brilliant order. As a teacher of chemistry he was no less popular. Lucid in his explanations, and conclusive in his reasonings, he presented to the youthful mind the dry bones of science in an attractive and intelligible form, and being himself an earnest and persistent student of almost the whole circle of the sciences, he was a worthy guide and example to the students under his charge. He was ever ready, at any personal inconvenience or cost, to help forward every movement calculated to disseminate science amongst the masses, and laboured with characteristic zeal to knit together North Country chemists in the bonds of fraternity. In virtue of this, he was one of the originators and promoters of the flourishing Chemical Society of Newcastle, to whose literature he was a valuable contributor, and in whose proceedings he ever interested himself warmly: it need scarcely be added that his death will be acutely felt by its members. His old students will lament the removal of one whom they almost revered, and certainly looked upon as the very embodiment of a profound chemist and successful teacher, and every admirer of rare ability and exceptional individual merit will regret the death of one who, just in the prime of life, has been taken from the profession which he adorned so much and loved so well.

NOTICES OF BOOKS.

Report on an Investigation of the Character and Chemical Constitution of the Fibre of the Flax Plant. By F. HODGES, F.C.S., &c.

THIS paper is a reprint from the *Proceedings of the Royal Irish Academy*, and is of no small importance as throwing light upon the fundamental principles of bleaching. The author points out that the experiments upon which Kolb's report is based (1868) were made exclusively upon yarn spun with Russian dew retted flax. He has therefore found it necessary to repeat the experiments with Irish flax, and has made a special study of the wax and other bodies in addition to cellulose found in the stem of the flax-plant. He states that iodine and sulphuric acid render the cast-hell blue, whilst sulphate of aniline on the unbleached fibre shows the presence of some adhering and encrusting matter by the production of a yellow colour. In the perfectly purified and bleached fibre this reagent usually causes no change of colour, unless some of the encrusting matters have not been removed. The short cells and vessels situate on the inner side of the bast bundles of the plant are not rendered blue by the action of iodine and sulphuric acid.

In operating upon pure Irish milled flax of medium quality, the author found the loss of weight, after drying twelve hours, equal 9.7 per cent. His next step was the examination of the so-called wax, or gummy matter which is originally spread in a uniform manner over the surface of the fibre, but which after retting takes the form of bril-

liant scales, much of which, it is remarked, is removed from the fibre by the mechanical process of hackling. The substance in question has not been thoroughly examined. Berthelot viewed it as a yellow pigment; Kirwan as a resinoid, differing from the true resins by being insoluble in the essential oils. De Lisle considered it to partake of the nature of gummy extractive matter, whilst Grimshaw attributed the colour of raw flax to the presence of iron. The author, by treatment with ether, obtained a solution which gradually turned light green and finally darkened, and on cooling deposited a white substance in flocculent masses. On distilling off the ether from the solution whilst still hot, there was obtained a mass of a waxy matter and of essential oil,—the latter in too small quantities to admit of close examination. The wax appears to be of a complex nature, but the author has recognised in it cerotic acid.

On treating the flax which had been previously extracted with ether and alcohol, with caustic soda, a liquid was obtained which with excess of hydrochloric acid gave a precipitate—apparently metapic acid. This precipitate was found insoluble in absolute alcohol and ether. The author here remarks that a substance obtained from jute by Messrs. Cross and Bevan, whilst working in a similar way, was soluble in alcohol, and therefore could not be a picic acid.

The author's experiments are far from being completed, and will, without doubt, lead to important results, both of a scientific and of a technical nature.

CORRESPONDENCE.

READING BURETTES.

To the Editor of the Chemical News.

SIR,—I recently invented a method by which the reading off of burettes may be accomplished in a very accurate manner, and think it may be of service to some of your readers. The only apparatus required is a small mirror, on the surface of which are pasted two strips of black paper, each, say, about $2'' \times 1''$ wide, with a space of about $\frac{1}{4}''$ between them. When reading off, the operator places the mirror behind and in contact with the burette, taking care that he can see the reflection of his eye in the space between the strips of paper, the top of the solution of course being also in the space.

In this latter precaution lies the efficacy of the method, as, no matter what the height of the solution, the eye of the operator must needs be at right angles to the burette when reading off the scale, and hence his readings will be always correct.—I am, &c.,

JAMES H. McMAHON.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 8, February 20, 1882.

Double Salts of Mercury.—M. Berthelot.—A thermochemical examination of mercurial iodides and chloroiodides.

Practical Solution of the Problem of the Transmission of Force to Great Distances.—Maurice Levy.—The author examines if it is possible to transmit a given quantity of energy to any distance whatever, obtaining a yield as close as possible to the required unity, under the

twofold conditions of not exceeding a given electromotive force and of employing merely machines commonly met with, such as those of Gramme and Siemens. He decides the question in the affirmative.

Compass without Resistance, intended for Measuring Intense Currents.—MM. Terquem and Damien.—This paper requires the accompanying diagram.

Saturation of Phosphoric Acid with Bases and on Chemical Neutrality.—A. Joly.—The author refers to the conclusion of MM. Berthelot and Louguine that phosphoric acid is not, strictly speaking, a tribasic acid in the same sense as, e.g., citric acid, and that it should be more properly regarded as a mono-basic acid with mixture function. He finds that the solutions of ordinary phosphates with a single equivalent of base, soda, potassa, or ammonia, which redden litmus strongly, are neutral to helianthine, like the corresponding nitrates. The first equivalent of alkali behaves therefore with ordinary phosphoric acid as it does with the monobasic acids properly so-called.

Hydro-ferrocyanic Acid.—M. Joannis.—The formation-heat of hydro-ferrocyanic acid, from the combination of its elements, is +93.6 cal.

Action of Iodine upon Naphthalene at High Temperatures.—A. Bleunard and G. Vran.—Iodine withdraws hydrogen from naphthalene forming hydriodic acid, and there is produced a new body, $(C_{10}H_6)_x$, which represents naphthalene less two atoms of hydrogen.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. x., Part 10.

Knop's Method of Improving Soils as Applied in Denmark.—C. F. A. Tuxen.—It is remarked that soils with high absorptive power may be poor if such power depends on a high proportion of humic acid and humates.

Results of the Principal Manurial Experiments carried out by Lawes and Gilbert in England, and their Value for German Agriculture.—Dr. P. Behrend.—A summary of the results of the Rothamsted experiments.

Excretion of Urea.—H. Oppenheim and J. Mayer.—The former author has examined the daily distribution of the excretion of urea, the influence of great quantities of water, of coffee, of quinine, of perspiration, and of muscular work. Mayer concludes that the elimination of urea does not increase with the elimination of water.

Absorption in the Stomach.—H. Tappeiner.—The stomach has, in comparison with the bowel, little power of absorbing aqueous solutions, but absorbs readily dilute alcohol and bodies dissolved therein.

Digestion of Cellulose.—Dr. Hofmeister.—The mixed saliva of the horse is almost without action upon crude vegetable fibre.

Experiments on the Formation of Fat in the Animal Body.—Prof. F. Soxhlet.—The fat formed during the fattening of animals is produced mainly from carbohydrates.

Excretion of Gaseous Nitrogen from the Animal Body.—Prof. M. von Pettenkofer and C. von Voit.—In opposition to Seegen and Nowak, the authors maintain that no nitrogen is excreted save in the urine and dung.

Vol. x., Part 11.

Action of Different Phosphates on Dry and Moist Sandy Soils.—H. Schultz-Lupitz.—Steamed bone-dust gave the best results. Peruvian guano, both crude and dissolved, and patent manures, were dubiously remunerative.

Results of the Manurial Experiments of Lawes and Gilbert.—Dr. Paul Behrend.—Continued from the last number.

Archives Néerlandaises des Sciences Exactes et Naturelles.
Tome xvi., Livraison 3.

This issue contains no chemical matter.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome viii., December, 1881.
This number contains no chemical matter.

MISCELLANEOUS.

The Chemical Laboratory of Wiesbaden.—Besides the Director, Geh. Hofrath Prof. R. Fresenius, there are engaged as teachers in the establishment, Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Oberlehrer F. Henrich, and Architekt T. Brahm. The assistants in the laboratory in the Winter Term, 1881-2, were twelve in number, and in the Versuchsstation two. In the Winter Term, 1881-2, there were 56 students on the books. Of these, 39 were from Germany, 4 from England, 4 from North America, 3 from Austro-Hungary, 2 from Sweden, and 1 from France, Spain, Russia, and South America. Besides scientific researches, numerous analyses were undertaken in the laboratory and the Versuchsstation on behalf of manufacture, trade, mining, and agriculture.

Note on Aconite Poisoning.—A sparrow was poisoned with scrapings of aconite root, and died within an hour. On opening the viscera, nearly all the root (weighing perhaps one-tenth grain) was found in the gizzard, very little being left in the crop. The contents of crop and gizzard were mixed, evaporated to dryness under 60° with a drop of tartaric acid, the residue digested for some hours with alcohol in the cold, and the filtered extract evaporated (below 60°) to dryness and taken up with a few drops of water. Some bread crumbs soaked in one half of this solution and administered to a tom-tit, killed the bird within two to three hours. In the other half of the solution no aconitine could be detected either by the taste or chemically.—JOHN M. H. MUNRO, D.Sc., College of Agriculture, Downton.

MEETINGS FOR THE WEEK.

- SATURDAY, 11th.—Physical, 3. "Experiments on the Formation of Fogs," by Mr. Newth.
MONDAY, 13th.—London Institution, 5. Royal Institution, 3. "Animal Movements," by Mr. Maybridge.
— Medical, 5.30.
— Society of Arts, 8. "Hydraulic Machinery," by Prof. John Perry.
— Society of Chemical Industry, 7.30. "Note on a New Source of Potash Alum," by Mr. J. Spiller.
— "The Manufacture of Alumina Sulphate," by Mr. B. E. R. Newlands.
TUESDAY, 14th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 5.30.
— Photographic, 8.
— Meteorological, 7.
— Gases, "by Prof. J. G. McKendrick."
WEDNESDAY, 15th.—Society of Arts, 8. "Gas for Lighthouses," by John R. Wigham.
— Meteorological, 7.
THURSDAY, 16th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Chemical, 8. "On Valency," by Dr. Armstrong.
— "On Pentathionic Acid," by Watson Smith and T. Takamizawa.
— "On some Constituents of Resin Spirit," by G. H. Morris.
— "On the Preparation of Diethyl-naphthylamine, and the Action of Sulphuric Acid on that Substance," by B. Smith.
— London Institution, 7.
— Royal Institution, 3. "Remembrances of Sound, Light, and Heat," by Professor Tyndall.
FRIDAY, 17th.—Royal Institution, 9. "Infra-red Rays of the Spectrum," by Captain Abney.
SATURDAY, 18th.—Royal Institution, 3. "Volcanoes," by Prof. H. G. Seeley.

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.
Arsenic in Commercial Muriatic Acid.—Will any of your readers kindly inform me whether a sure test for the presence of arsenic in commercial muriatic acid exists which can be readily applied by workmen?—E. H. MORTON.

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THE CHEMICAL NEWS.

VOL. XLV. No. 1164.

ON THE ATOMIC WEIGHT OF BERYLLIUM AS DETERMINED BY ITS PHYSIOLOGICAL ACTION.

By JAMES BLAKE, M.D., F.R.C.S., Calistoga, California.

NOTWITHSTANDING the many experiments that have been made to determine the atomic weight of beryllium, its true position amongst the elements is still undecided, as is shown by the conflicting views of Nilson and Pettersson (*Berichte der Deutschen Chem. Gesells.*, vol. 14, p. 1451) on the one hand, and of L. Meyer (*Berichte*, 14, 1780), Brauner (*Berichte*, 14, 55), Carnelly, and Watts on the other. As the physical properties of the metal and its compounds have not so far furnished data to determine its true position amongst the elements, I think the evidence derived from the physiological action of its salts may be of use in deciding the question. In a paper read before the Royal Society in 1840, I first published the fact that the physiological action of inorganic substances when introduced directly into the blood of living animals, was determined by their isomorphous relations, all the substances in the same isomorphous group causing analogous physiological reactions. In 1870, in a paper read before the California Academy of Sciences, I showed that amongst the compounds of the more purely metallic elements in the same isomorphous group, the intensity of physiological action was determined by the atomic weight; the higher the atomic weight of an element in the different isomorphous groups, the smaller the quantity required to cause the same amount of physiological action. Applying these facts to the determination of the position of beryllium as a member of the magnesium or of the aluminum group of metals, we have to ascertain if its salts, when introduced directly into the blood of living animals, give rise to physiological reactions analogous to those that characterise the salts of the Mg group, or such as are produced by the introduction into the blood of the salts of alumina and ferric oxide. We then have to consider if the quantity required to produce these reactions is in proportion to the atomic weight of the substance, considered as a member of one or the other of these isomorphous groups. This is not the place to enter into any detail as to the physiological action of these substances. I will merely state that the effects that are produced by the introduction of the salts of Be into the blood are the same as those caused by the salts of alumina and ferric oxide, and are strikingly different from the physiological reactions that are caused by the salts of the magnesium group of metals. As regards the quantity required to produce these physiological reactions, this also agrees perfectly with its atomic weight as a member of the aluminum group. In the rabbit the quantity of $MgSO_4$ per kilo. required to produce death is about 0.97 grm., and if beryllium were a member of the same group it would take about 1.5 of the sulphate to cause death. As a member of the aluminum group the quantity would be much less, as alumina sulphate is fatal in the quantity of 0.007 Al_2O_3 per kilo., and ferric sulphate with 0.004 Fe_2O_3 per kilo. The intensity of physiological action of the salts of beryllium is in accordance with its atomic weight as a member of the aluminum group, as it requires 0.023 of the sulphate to cause death, or about one-seventieth part of what would be required did it belong to the magnesium group. The facts furnished by the physiological action of the salts of Be plainly point out its position as a member of the aluminum group of metals. They certainly

do not admit of being interpreted as favouring either view of its position as seems to be the case with the evidence derived from the physical data that have been used to determine the question, for whilst the specific heat of the metal, the molecular volume of its oxide and of its sulphate, the molecular heat of the oxide, the atomic heat of the combined oxygen, and its general chemical characters serve to convince Nilson and Pettersson that the atomic weight is 13.65 and its oxide Be_2O_3 , these same data serve Brauner and L. Meyer to conclude that the oxide is BeO , and the atomic weight 9.11. I shall not here attempt to weigh the evidence that has been adduced in favour of Be being a member of Mg group. The fact that a substance is required with an atomic weight of about 9 to fill a vacant place in the Mendeleeff series of elements, and that whether beryllium can fill this place is regarded, *als eine lehrsage des periodischen systems* (Brauner, *loc. cit.*, p. 54), has perhaps unconsciously influenced the judgment of the strenuous supporters of this law in weighing the evidence. It would be well to remember that in the use of these physical constants to determine the molecular structure of the elements, no hard and fast lines can be drawn which would justify the assertion that their application is absolute. Exceptions are met with to the laws of Dulong and Petit, and to the law of Avogadro, which, in the present state of chemical science, we cannot account for. Even as regards the physiological action of isomorphous substances, a striking exception is found in the salts of potash, as I have stated in a paper containing a short resumé of my experiments published in the *Berichte*, vol. 14, p. 394 (an abstract of this paper was published in the *CHEMICAL NEWS*, vol. xliii., p. 191). After performing some hundreds of experiments in ascertaining the physiological action of compounds of more than forty of the elements, I certainly consider that the evidence furnished by the physiological action of the salts of beryllium as decisive of its position as a member of the aluminum group of metals.

NOTE.—In an article published in No. 17 of the last volume of the *Comptes Rendus*, entitled "De la Toxicité Comparée de Différents Métaux," by M. Ch. Richet, experiments are related that have been performed by placing fish in water in which metallic salts had been dissolved, and noting the quantities of different salts required to produce death. After alluding to the chemical classification and the atomic weights of the substances employed, M. Richet states, "Il ressort ainsi de ces expériences qu'il n'y a pas de relation à établir entre la fonction chimique et la puissance toxique." The most elementary knowledge of physiology would suffice to show how worthless are such experiments in disproof of the facts I have brought forward, as substances introduced into the stomach or to the breathing organs do not afford any criterion for judging what would be their action when introduced directly into the blood. Were I writing in a physiological journal I should not think it necessary even to allude to such experiments, but as chemists, it would seem, are not all acquainted with the great difference there is in the physiological action of substances according as they are introduced directly into the blood or slowly absorbed through mucous membranes, I take this opportunity of calling attention to this important fact.

Certain Phosphates Neutral to Litmus.—MM. E. Fihol and Senderens.—If we add gradually and very carefully to a solution of pure phosphoric acid, a solution of pure caustic soda, there arrives a point when the liquid restores the vinous tint to tincture of litmus either reddened by an acid or turned blue by a trace of alkali. This neutral liquid can be crystallised in an exhausted receiver over sulphuric acid. The crystals thus obtained are neutral to litmus; they are oblique rhomboidal prisms, containing 3 equivs. of crystalline water. They may be regarded as composed of 1 mol. of mono-sodic phosphate combined with 1 mol. of di-sodic phosphate.—*Comptes Rendus*.

ON THE APPLICATIONS OF TANNIN.

By M. JUSTE KÖCHLIN.

TANNIN and the tannates are at present the mordants best suited for the alkaloidal colours. This property was recognised soon after the appearance of these colours. In 1856 the violet of Perkin was fixed by tannin, or by astringent bodies which contained it. Tannin, in principle, was not merely no novelty, but was perhaps the most ancient drug used in dyeing, as it figured under the form of galls, sumach, quercitron, myrobalans, bablah, gambier, &c. These astringents may play various parts. By means of their tannin they render aluminous mordants less easily attacked by acid colouring matters, hence occasioning economy so much more appreciable as the water is more calcareous. In virtue of their tannin they blacken iron mordants, and by their colouring matters they may add to the general tone or serve independently of colouring matters. These astringents have also important applications in other industries: they serve for weighting silks, for tanning skins, for making inks, and as antiseptics.

If tannin serves as a mordant for alkaloidal colours, it is by reason of its property of forming insoluble compounds with these colours. This property exists also in the insoluble metallic tannates, and these bibasic salts have the advantage of not dissolving in an excess of the colour. These mixtures of tannin and of colour give in fact both soluble and insoluble compounds, lakes which dissolve in an excess of tannin. This property renders dyes without a metallic oxide very delicate. This condition disappears when the tannin is changed into an insoluble metallic compound by means of tartar emetic, or pyrolignite of iron, or neutral alum, or dilute stannic chloride, or subacetate of lead, or gelatine, or potassium chromate.

To prepare the most insoluble compounds, or lakes of tannin, with the following colours there are required:—

To 4 parts magenta (rosaniline hydrochlorate), 5 tannin, 2 soda crystals.

To 4 parts aniline-violet (penta-methylated rosaniline hydrochlorate), 5 parts tannin, 1 soda crystals.

The same proportion holds good for malachite green:—

For 4 parts methyl-green, 10 tannin, 4 soda crystals.

For 4 parts methylene-blue, 5 tannin, 4 tartar emetic.

Methylene-blue with five times its weight of tannin forms a soluble compound. Finally to precipitate the tannin are required, to 5 parts, 1 part tartar emetic, and 1 soda crystals.

These proportions, which form lakes or the most complete precipitation, are not equivalent quantities, nor are they suitable for mixing steam colours. It is common to take tannin double the weight of the colouring matter for magenta and aniline-violet, triple for the greens, and as much as fourfold for methylene-blue. Tannin colours contain, besides, tartaric acid and the quantity of sodium sulphite necessary for their reduction. Tartaric acids acts as a solvent, and prevents colours fixed with tannin from becoming saddened. Nevertheless, we meet with colours so charged with metallic chlorides that tartaric acid cannot be added to them except in very small quantity for fear of injuring the vegetable fibre. Sodium bisulphite increases solubility and brightness. This reduction requires, even in certain cases, the addition of zinc powder. When reduced in this manner methylene-blue may be mixed with alizarin colours without the assistance of tannin. Some of these colours gain in intensity if applied upon cloth prepared by immersion in tartar emetic before washing. They can then bear soaping at a boil, but they do not become faster as against the light of the sun. The passage through tartar emetic is effected with a hot solution of 10 to 20 grms. per litre, and the time of passage is one minute. The final transformation of tannin steam colours into insoluble metallic tannate is quite as necessary for

preparations of pure tannin intended for dyeing as for these colours. In either case it completes the fixation, and prevents the diffusion of the tannin in the dye-baths.

Tannin, or the astringents containing it, may be condensed on vegetable fibre without the intervention of an intermediary or a mordant. The solutions of these substances may yield their tannin alternatively either to the solvent or to the fibre. These preferences, or restitutions, are effected according as the degree of concentration gives a preponderance to the fibre or to the liquid. Thus cotton, which would be tanned in an astringent bath of a certain concentration, loses some of its tannin in a water which contains less tannin, and is completely and rapidly untanned in flowing water. This loss in water which still contains tannin does not represent an equal division between the tannin and the water. We observe more resistance on the part of the fibre than on that of the solvent. Thus cotton impregnated with tannin at 50 grms. per litre, and which would be completely untanned in pure water, would preserve all its tannin in a solution of 5 grms. per litre: it continues taking up tannin in a solution of 20 grms. per litre, but begins to be impoverished in water containing less than 2 grms. The tannin which the fibre has withdrawn from the solvent may return to that liquid as soon as the necessary degree of concentration no longer exists. Similar alternations may be observed with picric acid, eosine, &c.

In dyeing cotton absorbs tannin slowly. The process cannot be accelerated by heat beyond 50° or 60°. Above this limit the solvent no longer yields tannin, and the fibre begins to give it up again. This is one of the reasons why preparations in pure tannin require to be dried in hot air, and why they become streaky on drying cylinders heated with steam.

There are two methods of tanning cotton, by dyeing or padding. In the latter case the solution must be ten times stronger. In either case it will be found advantageous to transform the tannin into an insoluble salt, after which washing is practicable, and the homogeneity of the dye-baths is preserved. Steaming or drying goods prepared with tannin does not fix them, and does not hinder them from being untanned by water. For dyeing, 1 grm. tannin per metre of cloth and per 2 litres of water for an hour will give a mordant which takes a decided grey in acetate of iron; 10 grms. give a very deep grey, and 20 grms. a black. These dyeings done in the cold are more intense than at 50° or 60°. 100 grms. of tannin per litre padded, dried and passed into tartar emetic at 20 grms., will give the deepest shades on dyeing in methylene-blue.

By dissolving methylene-blue in an excess of tannin, the latter being in greater proportion as the bath is more dilute, it is possible to dye directly a light blue.

To obtain a heavy blue saturate in tannin at 24 grms. per litre, dry, fix in acetate of iron at 14° B., neutralised with 25 grms. chalk per litre; wash, dye in methylene-blue, and soap. A passage in acid, or in acid and sulphite, will withdraw from this blue the black matter which darkens it.

With iron and astringents calico-printers have compounded colours ever since the rise of this industry. We may thus obtain black with 1 litre tragacanth mucilage, 1 litre pyrolignite of iron at 18° B., 125 grms. tartaric acid, and 250 grms. tannin. By diluting this colour we obtain greys rivaling the alizarin colours in fastness. These greys may be dyed with other colouring matters, and preserve their tone on cloth prepared with stannates. Gallic acid greys are purer than tannin greys, but they are wanting in solidity.

Since the acquisition of the aniline colours tissue-printers make frequent use of the process of dyeing which consists in turning the mordants into tannates. These mordants, after dunging, are dyed in tannin with the addition of gelatine. This mixture, which preserves the white of the parts not mordanted, is added in fractions as it is absorbed, to prevent the coagulation of a concentrated mixture of glue and astringent. After this preparation a soap-bath at 60° withdraws the tannin from the parts not mordanted,

and the goods may then be dyed in green, violet, blue, &c. This process allows of designs with white discharges applied upon the mordant.

Mordants may be mixed at once with tannin, steamed, dunged, and dyed, as:—

| | |
|-------------------------|-----------|
| Gum water | 1 litre |
| Tartaric acid | 150 grms. |
| Tannin | 250 " |
| Red liquor, 16° B. .. . | 1 litre |

One of the most ancient uses of tannin was fixing mordants, especially in turkey-reds, where the process was known as galling. Gallnuts were used at first mixed with alum; then came steepings in infusions of sumach, galls, &c., followed by a steeping in alum neutralised. A padding in tannin at 50 grms. per litre, followed by a second padding in alum at 50 grms. per litre, neutralised with 50 grms. soda crystals, gives an immediate mordant, equally suitable for alizarin-reds and for aniline colours. —*Moniteur Scientifique*.

FIXATION OF ALUMINA AS A DISCHARGE ON INDIGO-BLUE BY MEANS OF ALUMINIUM CHLORIDE.

By G. SAGET.

THE property of hydrated aluminium chloride to be decomposed into alumina and hydrochloric acid when dried may be used for obtaining a discharge on indigo-blue, whilst alumina is deposited where the chloride has been printed, and may serve as a mordant for various colours. On adding manganese peroxide to the aluminium chloride Scheele's reaction is obtained upon the tissue, the nascent chlorine destroying the colouring matter and producing whites. This reaction requires the presence of water and a temperature of 100°. The aluminium chloride must be perfectly neutral. To prepare it alumina is thrown down from aluminium sulphate by means of ammonia. It is collected upon a filter, washed, and dissolved in pure hot hydrochloric acid, taking care always to have an excess of alumina. The clear liquid is decanted and evaporated until a crystalline layer forms on the surface. The chloride is then of a syrupy consistence, and partially crystallises on cooling. When it is to be used the crystals must be thoroughly mixed with the supernatant liquid. As for the manganese peroxide it is preferable to use that formed by the action of chloride of soda upon a salt of manganese, washing, and drying at 100°. The commercial peroxide contains too much impurities. The product thus obtained is reduced to an impalpable powder. The following discharge is then printed upon a medium indigo blue:—

| | |
|-------------------------|----------|
| Manganese peroxide .. . | 80 grms. |
| Aluminium chloride .. . | 300 " |
| Calcined starch .. . | 200 " |
| Water .. . | 420 " |

After printing the pieces are steamed without pressure for an hour and a half, letting the vapours escape. There is obtained thus a design which is of a pinkish white, and which is cleared by a passage through weak hot hydrochloric acid. If the alumina is intended to serve as the mordant for a colour the pieces are washed in hot water, then in cold water, and dyed. In this manner the author has obtained upon indigo-blues fine designs in alizarin-reds, fustic, or quercitron-yellow, cerulein-greens, &c. The discharge above given is intended for a medium blue: for a light or a dark shade it must be let down or strengthened in proportion.

A precaution to be taken when preparing this discharge is to add the aluminium chloride last, otherwise there are formed clots very difficult to get rid of. The peroxide and the calcined starch are first mixed, then the water is added, and when the paste is very smooth the aluminium chloride

is stirred in by degrees. This discharge keeps well for a long time in a cool place. Manganic oxide may be substituted for the peroxide, but to obtain the same quantity of chlorine a double proportion of aluminium chloride is preferable. Hence, from an industrial point of view, the peroxide is preferable.

Lead peroxide gives with aluminium chloride an analogous reaction. The author has sought to prepare a mixture such that after steaming and a passage through a chromate a yellow discharge would be obtained. Unfortunately, such discharges do not keep, and are completely useless after the lapse of a few hours. The contact of the copper rollers decomposes them at once, lead chloride and alumina are precipitated, and hinder the action of the doctors. The result is the same if red-lead is employed. —*Moniteur Scientifique*.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING FEBRUARY 28TH, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE
LOCAL GOVERNMENT BOARD.

March 3rd, 1882.

SIR,—In this, our fourteenth monthly report, we lay before you the results of our analyses of the 161 samples of water collected by us during the month of February on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 161 samples, one was recorded as "turbid," one as "slightly turbid," and two as "very slightly turbid." The remaining 157 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from February 1st to February 28th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 23 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the Chelsea Water Company, one was recorded as "turbid," one as "slightly turbid," and one as "very slightly turbid." The remaining 20 samples were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the West Middlesex Company, the whole were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the Lambeth Water Company, the whole were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the Grand Junction Company, the whole excepting one recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the Southwark and Vauxhall Company, the whole were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It is observable that the steady improvement in the colour of the waters, and in their freedom from organic matter, to which we called attention in our last report, has been continued during the present month. This year, more early than usual, the waters have ceased to manifest the features characteristic of the winter season.

We have the honour to remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ESTIMATION OF ALKALOIDS BY POTASSIUM MERCURIC IODIDE.

By ALBERT B. FRESCOTT.

In 1862, Ferdinand F. Mayer, of New York, reported* the uses of a standard solution of mercuric iodide with excess of potassium iodide, in a method of volumetric determination of the chief natural alkaloids. The standard solution was a "decinormal," or, taking Hg at 200, a twentieth normal solution of $(\text{HgCl}_2 + 6\text{KI})$, and has been generally known as Mayer's solution, in use for qualitative as well as quantitative purposes. Mr. Mayer so far extended his investigation that, for twelve alkaloids, he stated the number of milligrams of alkaloid precipitated by a cubic centimetre of his standard solution. These volumetric factors coincided with molecular quantities, proposed by theory and approved by experiment. The stated quantity of each alkaloid represented its equivalent weight, or the half its equivalent weight, or the whole or the third of twice its equivalent weight. The general correctness of the factors declared by Mayer has obtained frequent confirmation, though, as will be specified further on, some of his numbers have been found to require adjustment, irrespective of molecular quantities, and the combining numbers of some of the alkaloids of his list have become unsettled. Moreover, it has been found that the proportion of alkaloid to iodomercurate is in many cases varied by conditions, so that limits of dilution, time, temperature, &c., need to be prescribed. As a working process there still lacks an indicator for the end of the reaction,—one recommended by Mr. Mayer being palpably fallacious. Another demand for more investigation of the subject lies in apparent discrepancies between the volumetric factors of precipitation and some gravimetric analyses of the precipitates. Upon several of these questions I have at various times obtained some work, reaching as yet few conclusive results, but which may serve even now, with a careful study, to put the subject and its deficiencies in a more tangible shape.

A few years before Mr. Mayer's report, Thomas B. Groves, of Weymouth, England, communicated an investigation "On some Compounds of Iodide and Bromide of Mercury with the Alkaloids."† Mr. Groves obtained his compounds by precipitation with "a solution of three equivalents of iodide or bromide of potassium, and one equivalent of chloride of mercury" [$\text{Hg} = 100$], that is, the constituents of the reagent afterward standardised for volumetric use by Mr. Mayer. Mr. Groves introduces the alkaloidal mercuric iodides, &c., as a class of compounds which he believes has not hitherto been noticed, but in fact the qualitative reaction of alkaloids with solution of iodide of mercury and potassium had been communicated

some time before. It is referred to in "Gmelin's Hand-book," among the combinations of metallic iodides.* A. von Planta-Reichenau, in a good compilation on the reactions of alkaloids, presented as a dissertation at Heidelberg in 1846,† accords potassium mercuric iodide a prominent place among the general reagents for these bases. Mayer credits the first report of the use of potassium mercuric iodide as a qualitative reagent for alkaloids to F. L. Winckler, in 1830.

Mr. Groves made precipitates from solutions of "one equivalent of alkaloid," in salt and with some excess of mineral acid, and "three equivalents of iodide (or bromide) of potassium" with "one equivalent of chloride of mercury," and then made quantitative determinations of the mercury and the iodine of these precipitates. In these analyses, a dried and weighed portion of the [washed] precipitate was dissolved in boiling alcohol, and the solution treated with an excess of fresh ammonium sulphide, to precipitate the mercury as sulphide. The solution was kept hot, slightly acidulated with nitric acid, and the mercuric sulphide separated and weighed. The filtrate was warmed to expel all hydrogen sulphide, and treated with solution of silver nitrate, for the gravimetric determination of the iodine. The difference was estimated as alkaloid. Mr. Groves reported the precipitates as perfectly crystallisable, from hot water or hot alcohol, but did not take the crystalline form for analysis. He made analyses of the precipitates of morphine, strychnine, quinine, and cinchonine. In duplicate operations the results agreed with each other fairly, the variations of iodine percentage being from 0.17 to 0.82 per cent of the compound. The results are given in support of the general formula (translating Hg to 200), $\text{AlkH}(\text{HgI}_2)$. This could be generally referred to the rational form, $\text{AlkH}(\text{HgI}_2)$. However, the formula is not very well supported by the results. By computing the percentages of alkaloids for Mr. Groves's formulae we obtain:—

| | Calculated. | Found. |
|--|-------------|--------|
| Morphine in $\text{C}_{17}\text{H}_{19}\text{NO}_3\text{HgI}_2$ | 39.91 | 35.99 |
| mean, from 35.97 and 36.02 | | |
| Strychnine in $\text{C}_{21}\text{H}_{23}\text{N}_2\text{O}_4\text{HgI}_2$ | 36.50 | 33.03 |
| mean, from 33.20 and 32.87 | | |
| Quinine in $\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_4\text{HgI}_2$ | 35.80 | 30.14 |
| mean, from 30.40 and 29.88 | | |
| Cinchonine in $\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_4\text{HgI}_2$ | 34.64 | 29.08 |
| mean, from 28.56 and 29.60 | | |

Mr. Groves remarks that the obtained percentages of quinine and cinchonine correspond to molecular weights one-fourth less than those received.

A few months ago I obtained some determinations, by Messrs. Frank E. Judson and Charles E. Payne, of the percentages of iodine and mercury, in the iodomercurates of several alkaloids, namely, strychnine, morphine, quinine, and berberine. The analyses were done a little differently from those by Mr. Groves. The alkaloid precipitate was dried at 100° C., and a weighed portion dissolved in hot alcohol. It was found that the strychnine precipitate could be dissolved by acidulating the hot alcohol with sulphuric acid. Nitrate of silver solution was then added to precipitate the iodine, and the precipitate washed on the filter with hot water (dissolving out any silver sulphate precipitated by the alcohol), dried at 100° C., and weighed. The filtrate was treated with hydrochloric acid (in but slight excess), and the silver chloride filtered out, when this filtrate was charged with washed hydrogen sulphide gas, and the resulting mercury sulphide washed, dried at 100° C., and weighed. Having the iodine and the mercury, the fraction of hydrogen for the H of the assumed formula was added, and the difference placed as alkaloid. Triplicate operations were made. The analysis of the strychnine precipitate gave the following result, placed parallel with centesimals calculated from a molecular formula, and with the mean of Groves's percentages

* *Pro. Am. Phar. Assn.*, 1862, 238; and again, more fully *CHEMICAL NEWS*, viii, 159, and on opium alkaloids, *ibid.*, viii, 177, 189. *Am. Jour. Phar.*, 35, 20. *Zeitschr. An. Chemie*, 2, 235 (1863). *Jahresbericht der Chemie*, 1863, 703.

† *Quar. Jour. Chem. Soc.*, xi, 97, 188 (1849). *Jour. Pharm. Trans.*, 181, 101. *Jahresbericht der Chemie*, 1850, 363. *Am. Jour. Pharm.*, 36, 533.

* "Cavendish Edition," 2 (1849), 154.

† "Das Verhalten der wichtigsten Alkaloide gegen Reagentien," 41.

| | Calculated from $C_{21}H_{22}N_2O_2 \cdot HIHgI_2$. | | 1st. | Judson and Payne. 2nd. 3rd. | | Mean. | Groves. Mean. |
|------------------|---|--------|-------|--------------------------------|-------|--------|------------------|
| Iodine | 381 | 41'59 | 40'70 | 40'69 | 40'00 | 40'46 | 44'19 |
| Mercury | 200 | 21'83 | 18'50 | 19'60 | 21'20 | 19'77 | 22'78 |
| H of HI | 1 | 0'11 | — | — | — | 0'11 | — |
| Strychnine | 334 | 36'47 | — | — | — | 39'66 | 33'03 |
| | 916 | 100'00 | | | | 100'00 | 100'00 |

These results, in absence of direct determinations of the alkaloid, raise the question whether the iodomercurate of strychnine, as a precipitate, may not be in some degree complex and variable. This precipitate is one of the least soluble of the iodo-mercurates, according to Mayer, being obtained in a solution containing $1:11,000$ of strychnine. The end of the reaction is distinct, and the precipitate settles fairly in acidulated water, but better in concentrated solution of potassium chloride.* In this solution Dragendorff found each c.c. to dissolve 0.00216 grm. of the precipitate. Without potassium chloride, 0.1127 grm. of strychnine lost 0.0021 grm. in precipitating, washing, and estimating from the formula above assumed.† From these gravimetric experiments it appears that the precipitate in question must consist mainly, and may consist wholly, of double iodide of the formula $C_{21}H_{22}N_2O_2 \cdot HIHgI_2$.

The volumetric factor of 0.0167 grm. strychnine $1:11,000$ of $C_{21}H_{22}N_2O_2$ (in grms.), for 1 c.c. Mayer's solution (containing $1:11,000$ of $HgI_2 + 4KI$ in grms.), is well established. I have several times obtained its verification with pure crystallised alkaloid. Dragendorff quotes experiments confirming the ratio.‡ Now our understanding of the chemical equation, in the formation of these alkaloid iodomercurates, must depend upon the composition of the precipitate, as we have little knowledge of the chemical composition of potassium mercuric iodide solutions.

As a proposition we may take this equation—
 $(C_{21}H_{22}N_2O_2)_2H_2SO_4 + 2(KIHgI_2 + 3KI) =$
 $2C_{21}H_{22}N_2O_2 \cdot HIHgI_2 + K_2SO_4 + 6KI.$

This presupposes the following formation of Mayer's solution:—



The conditions of mixture of Mayer's solution seem to deny that it holds three molecules of free potassium iodide (as we have to specify further on). Nevertheless, some experiments in support of the above equations may be cited. A certain quantity (varied by temperature) of mercuric chloride may be added to Mayer's solution before a permanent red precipitate is attained. If, now, the solution just saturated with mercuric chloride, and containing the least perceptible precipitate of mercuric iodide, be treated with strychnine acidulated solution nearly to completion of the precipitate, and this be filtered out, the filtrate will not bear least addition of mercuric chloride without production of the red precipitate of iodide of mercury. That is say, all the iodide which is necessary to hold the mercuric iodide in solution enters into the precipitate of alkaloid mercuric iodide. The indication is that none of the iodide belonging to the potassium mercuric iodide and essential to its solubility becomes liberated in the precipitation with strychnine salt. These results are not peculiar to strychnine precipitation, as I obtained the same results with quinine, atropine, and acetonine. Another test, implying that soluble iodide is not liberated in the alkaloid iodomercurate precipitation, was made as follows:—Mayer's solution was saturated with mercuric chloride (to the point of precipitation), and then treated with excess of

quinine (and other alkaloid) acidulate solution, and filtered, when the filtrate would not precipitate mercuric chloride on its addition in any proportions.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

INSTITUTE OF CHEMISTRY.

At the Annual General Meeting of the Institute, which took place last month, the report of the Council was again most satisfactory.

The term during which the Council had the power of admitting members of the chemical profession to the Institute as Fellows without previously passing through the preliminary grade of Associate having expired, the qualifications required of Candidates for the Associateship have been carefully re-considered, especially with reference to the three years training demanded by the articles, and the examinations to be passed in physics, mathematics, and theoretical and practical chemistry.

During the session a conference has been held "On Certain Points in the Ethics of Professional Chemistry," the subject being introduced by Dr. Frankland, and it has also been determined to give a series of experimental demonstrations, illustrative of modern methods of analysis and of physical operations more immediately connected with chemical science; the first of these lectures, "On Modern Methods of Gas Analysis and the Apparatus employed therein," having been already delivered by Mr. Robert Warrington.

The Council has also given the most careful consideration to the question as to whether it might not be of service to the members, and conducive to the welfare of the society, to publish a journal, which should be sent periodically to the members; but as at the lowest estimate a really useful and comprehensive journal would absorb the entire available revenue of the society, the Council considers that it would be unwise to do so, especially considering how important it is for an institution of this character to accumulate funds. Moreover, the Society of Chemical Industry have now begun the publication of a journal, and it is a matter for the new Council to consider whether it might not be of use to the members of the Institute to make arrangements for its gratuitous supply to them. It would appear that some of the Fellows have entertained the expectation that the Institute should in some such way return to them a substantial equivalent for the annual subscription—as the Chemical Society does—but it must be remembered that the primary object for which the Institute was founded is to ensure that those who act as consulting and analytical chemists are qualified by study and training for the proper discharge of the duties they undertake. It is obvious, therefore, that the true functions of the Institute are the establishment of thoroughly efficient examinations in London and the Provinces, the public promulgation in every available way of the existence of the Institute, and of the position accorded to it by the profession, and the accumulation of such resources as will allow of all possible steps being taken to promote its public recognition, and as will, in course of time, enable the Institute to secure the permanent and elevated social position, which should be its right as the representative of

* Dragendorff, "Werthbestimmung starkwirkender Drogen" (1874), 62, 69.

† Ibid., p. 68. Strychnine 0.1127 grm., with 75 c.c. of Mayer's solution (an excess of 0.8 c.c.), gave a precipitate of 0.3023 grm. Then 0.3023 $\times 36.47 = 11.06$ strychnine obtained.

‡ Loc. cit., p. 62. Strychnine 0.0618 grm., in 10 c.c. solution, with 5 c.c. concentrated potassium chloride solution, required 375 c.c. Mayer's solution indicating 0.0626 strychnine.

the interests of the chemical profession, in the same way that the Colleges of Surgeons and Physicians represent the medical profession.

The guarantee which the Institute now furnishes will in each succeeding year of its existence increase in importance, and the status given by the Fellowship and Associateship become more fully recognised. Each successive year of its existence will see the objects of the promoters more firmly established and more fully developed, and, in due course, this Association, working steadily, though slowly, for the advancement of the welfare, the dignity, and public recognition of the profession, must, if loyally supported, take its place as one of the most important incorporated professional institutions of the United Kingdom.

PHYSICAL SOCIETY.

Saturday, March 11th, 1882.

Professor FULLER, Vice-President, in the Chair.

New Member:—Mr. D. Reece Jones.

Mr. NEWTH showed some experiments illustrative of the fact announced by M. Mascart in 1875 that solid particles in the air are necessary to the formation of fogs; and, secondly, that certain gases, such as sulphurous acid gas, also cause fogs in the same way by permitting the moisture to condense upon their particles. The experiments consisted in passing an electric light beam through large bulbs of glass containing air and a small quantity of water. When the air in the bulbs was washed with the water, and thus freed from mists, the fog produced in the bulb by slightly exhausting it with an air-pump was much less than when the air of the room, or smoke, or sulphurous acid gas was admitted into the bulb. The dust on a platinum wire, rendered incandescent within the globe by an electric current, also caused a sensible fog. It follows that with gas fires instead of coal there would still be fogs, though not so black ones.

Prof. F. GUTHRIE, F.R.S., read a paper "On the Discharge of Electricity by Heat." This was concerned with additional experiments to those made by the author on the subject nine years ago. He showed by means of a gold leaf electroscope that a red-hot iron ball when highly heated would neither discharge the positive prime conductor of a glass electrical machine nor the negative one; but on cooling the ball a temperature was found at which the ball discharged the negative conductor, but not the positive one. Lastly, on cooling the ball still further (but not below a glowing temperature), it was found to discharge both positive and negative electricity. A platinum wire rendered red-hot by an electric current also discharged a negatively charged electroscope more readily than a positively charged one. When placed between two electroscopes, one having a + and the other a - charge, it discharged neither. When the + one was withdrawn the - was discharged; but when the - was withdrawn the + was not discharged. There therefore seemed a tendency in a hot body to throw out + rather more than - electricity. That a material medium between the heated body and the electrified one was necessary was shown by the failure of the experiment with a Maxim incandescent lamp consisting of a carbon filament in a vacuum bulb. Dr. Guthrie also showed the demagnetisation of a small magnet in the heat of a Bunsen flame by inserting it in a coil of wire connected to a mirror galvanometer, and heating it in the flame. He also showed that the pole of a voltaic battery could be discharged by heating it red-hot. This was done by connecting a piece of fine platinum wire to one pole and heating it in the flame of a spirit-lamp, care being taken to insulate the lamp to prevent conduction to earth. The discharge was shown by means of a mirror electrometer.

THE METEOROLOGICAL SOCIETY.

DURING last year the Council of the Meteorological Society, having regard to the rapid progress of late years in statistical meteorology, and the uncertainty that still prevails regarding important questions relating the physics of the atmosphere, considered it desirable that the Society should supplement the ordinary observations by a series of well conducted experiments destined to throw light on such questions as the vertical decrement of temperature, the rate of ascension of vapour, the height of cloud strata, the variation in the velocity of the wind at different elevations, &c. Steps have been taken during the past week to make observations on the first of the questions by the placing of thermometers at the summit and base of Boston Church Tower, which is 270 feet high. This tower is admirably situated for making such experiments, as it is isolated and free from any obstructions, and the ground is quite flat for miles round. By permission of the vicar, Canon Hlenkin, the instruments have been placed as follows:—At the summit, one of Dr. Siemens's electrical thermometers (kindly placed at the Society's disposal by Messrs. Siemens, Bros., and Co.), and an ordinary thermometer, are mounted in a small screen fixed to one of the pinnacles of the tower; on the roof of the belfry, which is 170 feet above the ground, a Stevenson screen has been mounted containing maximum, minimum, dry, and wet bulb thermometers. In the church yard another Stevenson screen has been fixed containing a similar set of thermometers for comparison with those above. All the thermometers will be read every morning at 9 o'clock. The electrical thermometer consists of a coil of wire wound round a cylindrical piece of wood enclosed in a small brass tube; a third wire is joined to one of the wires, and the two, insulated by gutta-percha, form a light cable, which is brought down to the base of the tower and connected to a galvanometer, the terminals of which are in connection with the two poles of a six-cell Leclanché galvanic battery. The instrument is read by depressing a key which causes the needle of the galvanometer to deflect. A pointer or vernier (moving a contact roller upon a wire in a circular groove) is then pushed to the right or to the left upon a divided scale until the needle remains stationary on the zero-point, when the electrical resistance of the wire is measured upon the scale. The number indicated by the vernier is then read off, and by referring to a table of equivalents, the actual temperature in degrees of Fahrenheit is readily ascertained.

Simultaneous readings of the electrical thermometer at the summit of the tower, and of the dry bulb thermometer in the church-yard, will be made frequently during the day by the verger of the church.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, February 7, 1882.

R. ANGUS SMITH, Ph.D., F.R.S., &c., in the Chair.

"The Colour Sense and Colour Names," by WILLIAM E. A. AXON, M.R.S.L.

"Notes on Lead Pipes and Lead Contamination," by WILLIAM THOMSON, F.R.S.E.

The question of the contamination of water by lead pipes having been recently revived by Dr. Sedgwick Saunders's translation of M. Belgrand's brochure, made in accordance with the instructions of the Commissioners of Sewers of the City of London, I propose to bring before the Society a few notes on the same subject which may be of interest.

About three years ago I examined a sample of water to ascertain whether it contained any objectionable ingredients, and found it to be contaminated with lead to the

extent of 0.797 grain per gallon. The composition of this water was as follows:—

| | Grains Per Gallon. |
|--|--------------------|
| Total solid matter | 7.971 |
| Organic matter, combined water, &c. .. | 1.817 |
| Saline matter | 6.154 |
| The saline matter was composed of:— | |
| Chlorides of sodium and magnesium .. | 1.543 |
| Sulphates of soda and magnesia | 1.146 |
| Sulphate of lime | 2.388 |
| Carbonates of lime and magnesia and oxide of iron | 1.137 |
| | 6.154 |
| Free ammonia | 0.0028 |
| Albumenoid ammonia | 0.0035 |
| Oxygen contained in potassium permanganate required to oxidise organic matters, &c., acting in the cold during three hours | 0.028 |
| Nitrates and nitrites | absent |
| Total hardness | 3.8° |

I advised that this water should not be used for drinking purposes on account of the lead which it contained, and I afterwards learned that one of the members of the family, being ill and under medical treatment, suspected that there might be something wrong with the water in question, because she was better in health when away from her home, and it was only after lead had been detected in the water that lead poisoning was even suspected by the medical attendant, and it then became evident that the patient was suffering severely from lead poisoning, all the symptoms being strongly marked. The gums were tinged of a bluish shade and the fingers of both hands had become stiff and partially paralysed.

The interesting points connected with this case are that whilst a number of persons were using this water only one suffered severely from lead poisoning, although others of the family were in indifferent health previous to, and enjoyed good health after, the removal of the lead pipe which conveyed the water from the well to the house. As this lead pipe, which was in all probability the cause of all the unhealthiness of the family, had been in use for twenty-one years, it would have been interesting to have known the condition of health of the previous occupants of the same house, and if not satisfactory, to have learned whether or no any medical man diagnosed any of the cases as those of lead poisoning, as there seems little doubt that those who lived in this house must have suffered, more or less, from this cause. It seems, unfortunately, probable that many persons may be suffering from slow lead poisoning without the real nature of the malady being recognised by medical men, as it was in the case of the lady above mentioned, who by philosophical reasoning and experiment solved the problem which puzzled the doctor.

The house referred to was supplied from a well about 500 yards distant, the water passing by gravitation through a 1-inch lead pipe, and although this pipe had been in use for twenty-one years, and the water which passed through it contained certain proportions of sulphate and carbonate of lime, yet the pipe had not become coated as M. Belgrand says is the case with the lead pipe in Paris, and as is generally supposed to be the case, but was, according to the description of the owner of the house, as free from inside coating when taken out as it was when put in.

I was asked to suggest a substitute for the lead pipe, and advised the use of tin-lined lead pipe where the coating was about 1-16th to 1-20th of an inch thick, because some samples which I had obtained and examined several years before did not in the slightest degree contaminate water when kept in the pipe for many days. My suggestions

were carried out, and a sample of the water which had passed through this tin-lined pipe sent to me for examination. I found it to be contaminated with lead to a considerable extent, and on examining some of the tin lining I found it to contain a large proportion of lead. I sent to another manufacturer of this tin-lined pipe for a sample. This he sent me, and again I found that the tin lining contained a large proportion of lead, and quickly contaminated water left in contact with it. This I communicated to the manufacturer, who informed me that he could not understand how the tin lining had become contaminated, unless it was by its being poured down the side of a strip of lead into the hole left in the solidified lead in the cylinder previous to forcing it through the dies by hydraulic pressure. As I understand, this pipe is produced by pouring melted lead into a cylinder, through the top of which an iron shape is introduced to make a cavity in the lead of sufficient size to hold the necessary quantity of tin; the lead is then allowed to set; when this occurs the iron shape is withdrawn and molten tin poured in to fill the space which the iron shape previously occupied; a "die" composed of an iron tube with a core dips into the tin, which remains liquid in the cavity, whilst this outer tube forms the core of another tube through which lead is forced, the innermost core being prolonged, so that the tin comes in contact with and solidifies on the interior of the lead pipe. It seemed to me remarkable that a manufacturer who was cognisant of the fact that tin dissolved lead should have allowed such a device as the pouring of the tin down a strip of lead to be employed for filling the mould.

These tin-lined lead pipes, I understand, are used to a large extent, and principally in making communication between the beer in the cask and the pump on the counters of beer retailers. Such pipes would give the idea of safety, but it is clear that many samples of it may be of such a nature as to contaminate beer with lead to a large extent, as the beer contains a certain amount of free acid which would in all probability be capable of dissolving the lead; and one would expect that the person who consumes the first glass of beer from the pump in the morning would get that which had remained over night in the pipe, and would imbibe, therefore, a considerable quantity, depending on the quality of tin lining, of the poisonous metal.

To test whether this was really the case, a few days ago I got two samples of beer, drawn in the morning, from two pumps at the same place, and examined them, and found a considerable proportion of lead to be present in each. To find whether it was possible to obtain tin-lined lead pipe, in which the tin was free from lead, for making communication between the house and well above mentioned, I obtained a number of samples of this variety of pipe from the same and from different manufacturers, and tested the purity of the tin lining inside each, but failed to find one which was not contaminated with lead, and which did not contaminate water when left in contact with it for two or three days to a greater or lesser extent; one or two samples, however, contained very little lead, and only caused a minute trace of contamination in the water, but the majority contained a large percentage of lead, and polluted the water to a great extent. Ultimately, the gentleman who occupied the house referred to had the tin-lined lead pipe which replaced the lead one dug up, and communication with the well established by 500 yards of block-tin pipe; and since this change was made, he informed me lately that his family have enjoyed good health.

There is another kind of lead pipe manufactured called "tinned lead pipe," the inside of which is covered with a very thin coating of a white metal to afford protection against the action of water on lead—as a matter of fact, this coating is not tin at all. It is produced by filling the first few inches of the ordinary lead pipe which is forced through the dies, whilst still very hot, with molten tin, which remains molten and washes the inner surface of the lead tube as it is produced. Presumably, when a long

length of pipe has been forced through the dies, there would be little or no tin remaining, but I was informed by a manufacturer of this pipe that that is not the case; on the contrary, there is a much larger volume of tin, to use his own language, at the end of the operation than there was at the beginning; the molten tin dissolves the lead, thus increasing in volume, and so the coating is a mixture of lead and tin, the proportion of lead in the coating being greater in those portions of the pipe which are last forced through the die.

Some years ago, not knowing of the existence of this kind of tinned lead pipe, I requested a plumber to make for me a worm refrigerator with tin-lined lead pipe for the preparation of distilled water. He did so, and to my astonishment, on testing the distilled water which had been condensed in it, I found it to contain a large proportion of lead. On examination of the pipe afterwards I found it to be the variety which had been washed with tin. This coating cannot therefore be regarded as a thoroughly efficient protection against the action of water on lead, but the test was a severe one, and there can be no doubt that tin-coated lead pipe is much better adapted for use in making communication with the water mains in large towns than the ordinary lead pipe, whilst the cost of producing this coating, I understand, amounts to only a few shillings per ton of pipe. To test their respective values I placed water containing a small proportion of nitrate of ammonia in two pipes of the same sizes, the one tinned inside, the other the ordinary lead pipe. After standing about three hours I tested the water from each; the one from the tinned lead pipe contained only a trace of lead, whilst that from the ordinary lead pipe contained a large proportion of lead in solution. Similar results were obtained by leaving Manchester water in the same pipes for eighteen hours.

In certain boroughs, I understand, such as Salford, Oldham, and Southport, this tinned lead pipe is the only kind allowed to be used for making communication with the main, whilst in Manchester and other places ordinary lead pipe is generally employed. I have lately observed that the lead pipes which have been in use in Manchester for many years contaminate water left in them over the night to a considerable extent, but after the water has been used for a short time during the day it is free from any appreciable trace of lead.

I have also tested the water after remaining eighteen hours in the lead pipes in communication with the main in Salford where the tinned pipes are employed, and although the water was slightly contaminated with lead, it contained much less than that found in the water which stood for the same length of time in the ordinary lead pipes of Manchester.

It is a fact, which I have observed from my experience during the last few years, that aerated waters are contaminated with lead much more often, and in many cases to a much greater extent, than one would expect, considering the attention and care which is bestowed by good firms on the manufacture of these articles. Lately I tested several samples of what was termed "pure" carbonate of potash, and "pure" carbonate of soda, and citric acid, which were specially purified for use in the preparation of aerated waters, and I found all to be contaminated with lead to a greater or less extent. The manufacturer of these samples was apprised of this fact, and in reply he admitted that they contained traces of lead, but said it was impossible to obtain these substances free from metallic contamination at anything like reasonable cost, and he was quite satisfied that the quantity was not objectionably large. To overcome this difficulty I had to advise the use of the ordinary carbonate of soda, made by Solvay's ammonia process, as being almost as pure, and certainly much less likely to be injurious, than the purified salt. I also advised that those salts which it is impossible to obtain free from lead should be dissolved in water, and filtered through or boiled with animal charcoal, which has the property of removing the lead from solution. It

might here be noted that the use of charcoal filters diminishes very much the risk of lead poisoning, as the charcoal removes any trace of lead which the water might contain.

It was first discovered and afterwards published by the late Dr. Crace-Calvert and Mr. Richard Johnson in a joint paper, that pure lead is more easily acted on by sulphuric acid than lead containing a very small percentage of impurities such as antimony and copper, and these results have been repeatedly verified since. With a view to find the effect of pure water on comparatively pure lead and on lead to which I added $\frac{1}{2}$ of a per cent of antimony, I melted some of the original lead and poured some out, which I rolled into a sheet. Antimony was added to the remainder, and the mixture poured out and rolled into a sheet as before: both sheets were cut to the same size and placed in equal bulbs of distilled water and left overnight. In each case a fine white flocculent crystalline matter, an oxide or salt of lead, was observed in suspension, but this existed in considerably greater proportions in the water containing the lead which had not been treated with antimony. Thus the small quantity of antimony appears to afford some protection against oxidation of the lead by air and water. When the suspended matter was filtered off only a trace of the lead was found to be in solution in each case.

It is sometimes advisable to obtain the lead contained in water in a contracted solution, and preferably in an acetic acid solution if possible. I have observed frequently that weak acetic acid dissolves no lead from the residue left on evaporating waters which gave originally a very distinct colouration with sulphuretted hydrogen, but on treating the residue with strong nitric acid, evaporating off the acid completely and again treating the residue with weak acetic acid, the lead dissolves with apparent facility, and on evaporating this acetic solution of the metal to a drop or two, it may be obtained in a sufficiently concentrated solution for the application of the other tests. It appears as if certain organic matters contained in the water combine with and render the lead insoluble in acetic acid; these organic substances being afterwards decomposed by the nitric acid, leave the lead in a condition in which it is soluble in acetic.

A curious case of lead poisoning lately came under my notice and engaged the attention of a Lancashire coroner. A woman, upon whose body the inquest was held, had been employed in weaving cloth from yarn, which had been dyed of a yellow colour. The colour, which the ordinary chromate of lead, and it was alleged that the dye had caused her death by poisoning.

I examined some of this yarn, which I found to be of an orange-yellow colour due to the chromate of lead which had been fixed in the fibre, but it was so loosely fixed that by gently shaking a hank the chromate came out, forming a cloud of yellow dust, and it was given in evidence at the coroner's court that all or nearly all the workpeople who had been engaged in weaving this cloth suffered more or less from lead poisoning.

I afterwards examined some yarns containing the same pigment colour fixed in the thread so firmly that it could not be removed by shaking.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 9, February 27, 1852.

Induced Currents of Polar Interventions.—Th. du Moncel.—The author finds that the three effects of which he has spoken (*Comptes Rendus*, 1872, p. 1335, and 1879,

p. 353) are certainly operative in the Gramme machine, and that the currents of polar intervention are distinct from those resulting from the movement of a coil in a magnetic field fixed according to the axis of the magnetic ring.

Double Salts of Mercury.—M. Berthelot.—A series of thermo-chemical determinations.

Colouring-Matter forming in Starch Paste.—Lecoq de Boisbaudran.—The author laid before the Academy a specimen of a fine violet colour developed about fifteen years ago by the action of a small organism occasionally found on the surface of starch paste preserved for some time in moist air, and especially if exposed to the vapours of acetic acid.

Moniteur Scientifique, Quesneville.
December, 1881.

The Products of the Caoutchouc and Gutta-percha Industries at the Exhibition of 1878.—This paper as well as those succeeding, on glues, gelatins, inks, blacking, and starch, are not susceptible of useful abstraction, and their interest is chiefly historical.

Studies on Quinamine.—O. Hesse.—A translation from *Liebig's Annalen*.

New Salts of Platinum.—O. Hesse.—From *Liebig's Annalen*.

On Conquinamine.—O. Hesse.—Conquinamine and quinsmine are two isomeric bases which undergo modifications with equal ease and in the same direction, but which are not capable of mutual conversion.

A New Derivative of Quinine.—E. H. Rennie.—From the *Journal of the Chemical Society*.

On a New Alkaloid found in the Chinchonas.—M. Arnaud.—From the *Comptes Rendus*.

Gum Kauri in New Zealand.—From the *Journal of Applied Science*.

Coating Metals with Nickel.—A. Gaiffe.—The author describes the appliances required and the successive processes which the articles undergo, rather from the point of view of an amateur than of a manufacturer.

Industrial Society of Geneva.—Meeting of October 12th, 1881.—M. Stamm reported upon a communication by M. Degermann on black dyeing with logwood and iron and tin mordants, and on the black spots which sometimes appear on woollens dyed a cochineal-scarlet.

Proceedings of the Chemical Society of Geneva.—January 16th, 1881.—M. Kaspar gave an account of a specimen of insoluble albumen prepared from serum, at the Geneva Abattoir. It contained a proportion of sulphur three times greater than that of normal alcohol.

M. A. Danilewsky described his researches on myosine, its preparation, its transformation into syntonine, and its regeneration.

February 13th, 1881.—Prof. Monnier described a new method of determining nitric acid in spring- and well-waters.

Prof. Graebe described the researches of M. Mann on a novel homologue of desoxyberzoin, and of M. Herold on certain derivatives of ortho-anisidine.

March 12th, 1881.—Prof. Graebe exhibited certain apparatus for the volumetric determination of nitrogen, and for the electrolytic determination of copper in solutions where it is contained along with other metals. He made also some observations on the preparation of phosphorus trichloride.

Prof. Monnier exhibited a pocket apparatus for the rapid determination of urea and uric.

April 10th, 1881.—Prof. Graebe described the researches of M. Wolf on the production of anthragallol from anthracen.

M. Lossie gave an account of the electro-separation of metals as successfully employed at La Coulouvrenière.

May 8th, 1881.—Prof. Graebe described certain researches executed by M. Lauterbach on the sulpho-conjugated acid of dinitro-naphthalen, the potassium salt of which is known as "naphthaline yellow S." He made also some observations on the impurity of the benzoic acid of commerce, which may contain as much as 35 per cent of para-chloro-benzoic acid.

June 26th, 1881.—M. Aimé Piclet has prepared certain derivatives of dextro-tartaric acid, and studied them optically.

Prof. Graebe finds carbazol dissolved in sulphuric acid an exceedingly sensitive reagent for nitric acid. It produces a green colour.

Prof. Monnier proposes a new method for the analysis of milk. He pours into the sample a solution of copper sulphate, which precipitates all the caseine as copper caseate, carrying down with it the fatty matter. These two substances are separated by means of alcohol and ether. There remains in solution the milk-albumen, or lacto-proteine, which is also thrown down as a salt of copper on raising the liquid to a boil. (The sugar?) These solutions filter with great difficulty.

On Galleine and Cœruleine.—M. C. Buchka.—From *Liebig's Annalen*.

Improvement in the Manufacture of Crude Soda.—M. Louis Faucheaux.—The author patents an improvement in black-ash furnaces.

Adulteration of the Essential Oils.—From the *Journal of Applied Science*.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 3, November and December, 1881.

This number contains no chemical matter.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 15, 1881.

The Electric Battery at the Exhibition.—C. Maze.—A popular account of the nature and action of the battery in its different forms.

Modern Chemical Doctrines.—M. Gerber.—A lengthy summary, incapable of useful abstraction.

The Conveyance of Electricity.—A. Hamon.—This paper cannot be reproduced without the accompanying illustrations.

No. 16, December 22, 1881.

The late P. Secchi pointed out that certain characteristic movements of the compass, not merely accompany, but precede, grave atmospheric perturbations, even when the barometer is not affected.

No. 16, December 29, 1881.

Dr. Hélot, of Bolbec, gives a case of an epidemic of diphtheria in a previously healthy village near Caux. A tripe dealer had thrown quantities of animal refuse into a pond near his house, and when it was denounced as a nuisance the mud and the water were applied to the land as manure. A severe epidemic of diphtheria broke out, and lasted six months. A similar error was committed a second time and with the same results.

The Abbé Moigno asks for the loan of 10 grms. of cesium to enable a young chemist of his acquaintance to make some important experiments, and engages that it shall be afterwards returned.

Bulletin de la Société Chimique de Paris,
Tome 37, No. 1, January 5, 1882.

Normal α -Amido-valeric Acid.—V. Juslin.—This acid is very soluble in water, sparingly soluble in alcohol, and almost insoluble in ether. It sublimes without de-

composition. It crystallises in long colourless prismatic needles. Its composition is expressed by the formula, $C_2H_{11}NO_2$.

Manufacture of Potassium and Sodium Carbonates by the Direct Transformation of Chlorides by Trimethylamin.—J. Ortlier and A. Müller.—The Solvay process for the manufacture of sodium bicarbonate is known to be inapplicable to the preparation of the corresponding potassium salt. The authors propose to effect the transformation by using trimethylamin in place of ammonia. Their patented process is in action at the Chemical Works of Croix, near Lille.

MISCELLANEOUS.

The Purification of Water.—A method of purifying water, which bids fair to place dyers, calico printers, bleachers, paper and other manufacturers, and public water boards (who have now only a supply of inferior discoloured water) practically in the position of those who have a first-class source of supply, has, after numerous investigations and experiments, been developed into a practical process by Mr. Peter Spence, of the Pendleton Alum Works, and has during the last few weeks been tested on a very large scale at the waterworks of the Bolton Corporation. The Bolton water, as supplied to the ratepayers, outlying local boards, and manufacturers (compensation) contains a proportion of micaceous clay in such a peculiar state of suspension that neither filtration nor long settlement in reservoirs will remove its dirty opaque tint; probably no water, therefore, could have put the process to a more severe test. The trial referred to has been made at the Heaton Reservoir, one of the two service reservoirs supplying Bolton and district; the other, the Sweetlove's Reservoirs, has been left untouched. The result of the trial is that, whereas the latter contains a mass of water which, upon being looked at through the two-foot tube, over white paper, would be pronounced unfit for human beings to drink, the Heaton reservoir now contains some sixty million gallons, which is beautifully transparent and colourless, and has, in fact, a much finer appearance than the Manchester water. It may be added that this result has been achieved without hardening the water or introducing any new constituent into it (the iron naturally present is, in fact, removed by the process—a most important point for dyers and printers), or without in any way affecting the fish in the reservoir; and the cost of treatment so far has been proved not to exceed one half-penny per head per annum of the population. The Bolton Waterworks Committee have shown commendable enterprise in affording an opportunity for testing the process upon so large a scale, as they had incurred great expense in connection with a bill for parliamentary powers to borrow a large amount of money for filtering operations. They had also with this process to face the serious difficulty in the eyes of water engineers that the clay precipitated by it would be deposited at the bottom of their service reservoirs. Their venture has now been rewarded by the gratifying discovery that filtration has been proved an unnecessary and useless expense, and that at the least favourable estimate it would be some fifty-two and half years before one foot of clay had accumulated at the bottom of their reservoir. In the case of Manchester water the impurity is mainly in solution rather than in suspension, the peaty matter giving the water, in the two-foot tube, the disagreeable yellow tint which is so conspicuous over the white tile flooring of the public baths, and which, because it prevents bathers knowing whether the water is really clean, doubtless deters many from patronising them. According to the experiments of Dr. Angus Smith, of Manchester, who is probably the greatest living authority upon the impurities of air and water, and who, we learn, has a high opinion of this new mode of purification, the

comparative results are:—Distilled water, 33; Manchester water treated, 32; and Manchester water untreated, 14. Dr. Smith considers, moreover, that a notable proportion of the pernicious though invisible albuminoid matters would be removed along with the coloured and mechanical impurities. For manufacturers in Lancashire and Yorkshire this process has its chief interest in the fact that it throws down not only clayey and dissolved peaty matter, but the dye, tan, excreta, and other liquids refuse now poured in such volumes into our rivers. The black Irwell, Irk, and Medlock waters are completely decolourised by it; and thus any manufacturer who has a good sized reservoir, and is prepared to incur the expense of the new process, might locate himself at any point of our great sewer rivers and get as much good water out of these foul streams as he practically requires. In illustration of this statement it may be mentioned that the East Lancashire Paper Mill Company at Radcliffe has employed the process for many months. They state:—"In the hot and dry weather our water was often very bad and heavily charged with the refuse from bleach and dye works higher up the river; in fact, on a hot summer's day the smell in the mill was so unpleasant as to be hardly bearable, especially when the beating engine was partly filled with water previously to filling it." They add that since using the process "there is no smell whatever, and the water after being filtered is as clear as spring water." It may be mentioned that where the reservoirs are sufficiently large to deposit all the precipitate, filtration is quite unnecessary. Last, not least, the process has a direct bearing upon the important question of the prevention of the pollution of our rivers and streams. It has now been proved beyond controversy that if the waste liquid refuse of our manufactories and public sewers is dealt with in large settling tanks, the impurities can be readily precipitated, and a clear and colourless effluent obtained for the rivers. At two towns where the sewage is so treated by the precipitation process, and where Mr. Spence's material is employed, this result is now being regularly realised. But the process, however practically successful, will certainly not come into general adoption until the legislative screw is more vigorously applied. Various manufacturers and public authorities have, it appears, had their attention drawn to the new process, but we understand the reply given in every case is, "We shall not incur any more expense until we are absolutely compelled."

MEETINGS FOR THE WEEK.

- MONDAY, 20th.—London Institution, 5.
— Medical, 8.30.
— Society of Arts, 8. "Hydraulic Machinery," by Prof. John Perry.
TUESDAY, 21st.—Institute of Civil Engineers, 8.
— Pathological, 8.30.
— Royal Institution, 8. "The Mechanism of the Senses," by Prof. J. G. M'Kendrick.
— Society of Arts, 8. "Remarks on the Condition and Characteristics of some of the Native Tribes in the Hudson Bay Territories," by John Rae, M.D., LL.D., F.R.S.
WEDNESDAY, 22nd.—Society of Arts, 8. "The Tonic Sol-Fa System," by Spencer Curwen, A.R.A.M.
— Geological, 8.
THURSDAY, 23rd.—Royal, 4.30.
— Philosophical Club, 6.30.
— Royal Institution, 8. "Remembrances of Sound, Light, and Heat," by Professor Tyndall.
— Society of Arts, 8. "Some Practical Aspects of Recent Investigation in Nitrification," by R. Warrington, F.C.S.
FRIDAY, 24th.—Royal Institution, 9. "Electric Railways," by Prof. W. E. Ayrton.
— Quett Microscopical Club, 9.
SATURDAY, 25th.—Royal Institution, 3. "Volcanoes," by Prof. H. G. Seeley.
— Physical, 5. "Effect of Temperature on the Electrical Resistance of Mixtures of Carbon and Sulphur," by Sherrill Eldwell. "Measurement of Curvature and Refractive Index," by C. Vernon Boys.

THE CHEMICAL NEWS.

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ON THE SULPHATES OF ALUMINIUM.

By SPENCER UMFREYVILLE PICKERING, B.A. Oxon.,
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at Bedford College.

IN November, 1880, I had the honour of presenting to the Chemical Society the account of an investigation on the basic sulphates of iron (*Chem. Soc. Journ.*, 1880, 807), this being the first step of a research by means of which it is hoped that some light may eventually be thrown on those interesting but hitherto uninvestigated substances known as basic salts, and perhaps on molecular compounds in general. Thanks to a grant from the Government Research fund, made to me by the Royal Society, I have been enabled to continue this work, and now publish the results of some experiments on the sulphates of aluminium.

According to the existing literature of the subject, the basic sulphates of iron and aluminium are unparalleled amongst other salts for their number, and perhaps also for the ease with which they may be obtained. Those of aluminium are indeed not quite so numerous as the ferric sulphates, not more than nine having been described; but according to the present investigation, the fate of these nine sulphates should be similar to that of fourteen out of the fifteen basic ferric sulphates, it seeming highly doubtful, and in many cases being satisfactorily disproved, that any particular one of these bodies is a definite chemical compound.

I. The Aluminium Sulphate used.

It was found that all specimens of aluminium sulphate which were procurable in commerce contained a certain amount of potassium-alum as an impurity, and in order to obtain a pure substance it was necessary to concentrate a solution of the commercial substance till it partially crystallised, and filter off the remaining solution from the alum which by this process had separated out.

The solution employed in the following experiments was one which was nearly saturated at 0° C., and contained 16.614 per cent of the anhydrous sulphate, or 0.1955 grm. per c.c., its density was found to be 1.1767, and on a determination of the ratio of aluminium oxide and sulphur trioxide present being made, the following numbers were obtained:—

| | I. Found. | II. | Theory.* Per cent. |
|--------------------------------------|-----------|--------|-----------------------|
| Al ₂ O ₃ | 29.744 | 29.923 | 29.848 |
| SO ₃ | 70.256 | 70.077 | 70.152 |

Showing that the sulphate was free from excess of either acid or base. Very small traces only of potassium could be detected in it.

II. Method of Analysis and Washing of the Basic Sulphates

In analysing a solution of one of these basic sulphates in hydrochloric acid, it was found to be practically impossible to precipitate the sulphur before the alumina, as in the case of the ferric sulphates, the presence of aluminium in the solution causing the harium sulphate to pass through the filter. Happily, however, the aluminium hydrate precipitated from a solution containing sulphuric acid is not very difficult to wash. In an analysis, therefore, the aluminium was precipitated first with excess

of ammonia, the solution boiled* till it became neutral, the precipitate washed slightly, re-dissolved in hydrochloric acid, and then re-precipitated, the alumina being found, after this second precipitation, to be perfectly free from combined sulphuric acid. After the harium sulphate had been precipitated, traces of the aluminium were still found in the solution, and these were estimated by evaporating the liquid with ammonia and igniting the residue. The evaporations were conducted in platinum vessels.

This method of analysis admits of many sources of experimental error. To determine the extent of this error several analyses of pure alum were performed, and it was thus ascertained that the percentages given in this paper might err from the truth by as much as 0.3, although in the majority of cases they might be relied upon to within half of this amount.

Another source of inaccuracy presented itself, as in the case of the sulphates of iron. All the basic sulphates of aluminium are decomposed slowly on being washed with water, but, unlike the ferric sulphates, they yield a portion of their base as well as of their acid to the wash-water.

The ratio of the base to the acid thus dissolved was found to be about 20:80, which ratio varied but slightly in various cases; therefore this decomposition affected by the wash-water tends to render all the precipitates more basic than they were when first precipitated.

The precipitates were washed till the wash-water gave a slight cloudiness with harium chloride only after standing for some seconds, it having been found that after this point had been reached the sulphate in the wash-water continued to be nearly constant. About 100 c.c. of wash-water were usually required to effect the washing of 0.1 grm. of the basic sulphate.

Several determinations were made in order to ascertain the amount of the decomposition effected by the water, and though it was not found to be great, it was, however, appreciable, and would render all the percentage of alumina found somewhat higher than they should be. The general conclusions, however, arrived at in this paper will not be much affected by this fact, for, as it will be seen, they depend less on the non-concurrence of the analytical numbers with the composition of definite compounds than on proving that a continuous alteration in some one of the factors of the experiment produces a continuous variation in the composition of the precipitate formed.

Since the water contained in these basic sulphates seemed to be very variable, as in the case of those of iron, and to afford us no aid in attaining the ends in view, the precipitates were not dried,† but were analysed as soon as they had been washed in the manner detailed above, the ratio of the alumina and sulphuric anhydride present being alone determined.

III. Precipitation with Sodium Carbonate.

The tendency to form basic sulphates is certainly not so great in the case of aluminium as in that of iron, for a solution of the normal sulphate of the former of these metals remains perfectly clear when diluted with an indefinite amount of distilled water, and even where ordinary water is used, it requires an extremely large quantity of it to produce any visible cloudiness.

Series of experiments were made in which varying amounts of aluminium sulphate were treated with varying amounts of sodium carbonate solution, the proportion of water present being also varied. The results thus obtained are represented diagrammatically in the accompanying plate. The curves Nos. 1, 2, and 3 show the composition of the precipitates which are formed in the various cases.

* Unless the ammonia is entirely expelled in this way, as much as 5 per cent. of the alumina may remain in solution.

† An operation which was found to require many weeks at low temperatures, and to entail a loss of acid at higher ones.

* Al=27.02. See the recent determinations of the atomic weight of aluminium, by Mallet (*Chem. News*, vol. xli., p. 212).

The action here appears to be very different from what it is in the case of ferric sulphate; instead of a definite basic salt being precipitated by the addition of any quantity of the alkaline carbonate within certain limits, there is here a gradual decrease in the basicity of the precipitate followed by gradual increase until it finally consists of nothing but pure alumina, the quantity of sodium carbonate then added amounting to about 3.5 molecules (twice as much as in the case of iron) for every molecule of the normal sulphate taken. By comparing together any points in one of these curves with those vertically above or below it in the others, we see that an alteration in the amount of water present increases or diminishes the basicity of the precipitate according to the different points selected in the curves, and at no point is the influence of the water very great. The curves 4, 5, and 6

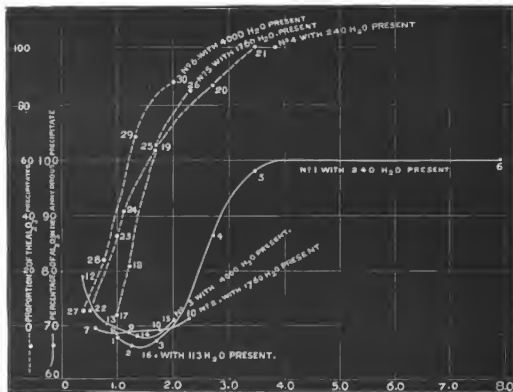
water present. The lowest portions of the curves indicate a basic body varying between the limits of $3\text{Al}_2\text{O}_3, 2\text{SO}_3$, which contains 65.69 per cent. of Al_2O_3 , and $5\text{Al}_2\text{O}_3, 3\text{SO}_3$, which contains 68.02 per cent. of Al_2O_3 , or perhaps $2\text{Al}_2\text{O}_3, \text{SO}_3$, which contains 71.85 per cent. of Al_2O_3 .

IV. Precipitation by Ammonia.

Maus (Pogg. Ann., xi., 80) states that by addition of potash and ammonia to solutions of potassium and ammonium alum respectively, solutions of basic double sulphates were obtained; in one case in which the potassium compounds were used, the solution on standing deposited a precipitate of $\text{Al}_2\text{O}_3, \text{SO}_3$; no analytical numbers, however, are given.

In order to ascertain the nature of the action of an alkali on aluminium sulphate, the experiments given in

ALUMINIUM SULPHATE TREATED WITH VARYING AMOUNTS OF SODIUM CARBONATE IN THE PRESENCE OF VARIOUS AMOUNTS OF WATER.



Molecules of Na_2CO_3 added to each Molecule of $\text{Al}_2(\text{SO}_4)_3$.

show approximately the amounts of alumina contained in the precipitates, as compared with the total amounts in the solution taken; it will be seen that the amounts thus precipitated vary between 4 and 100 per cent., while the point at which all the alumina is thus precipitated corresponds very nearly to that at which the precipitate first consists of pure aluminium hydrate. An increase in the amount of water present increases the actual amount of precipitate obtained, but not to any very large extent.

In these experiments the precipitates were not filtered off from the solutions until five days after the addition of the carbonate, which, in the majority of cases, was three days after the solution had ceased to give off carbon dioxide. In no case were the precipitates found to contain any appreciable amount of sodium or of carbonate.

Thus it is seen that the precipitation of aluminium sulphate by an alkaline carbonate affords no evidence whatever of the existence of any definite basic sulphate of this metal; the composition of the precipitate varies with the proportion of alkali added and with the amount of

Table I. were made, ammonia being the alkali used. In the first four experiments, increasing quantities of ammonia were added to various portions of the sulphate, and the precipitates were filtered off after the lapse of a few minutes; in the last of these experiments (34) a considerable excess of ammonia was present. The results here obtained indicate that the precipitate increases gradually in basicity as the quantity of alkali added is greater.

As the precipitate first deposited dissolves to a considerable extent when allowed to remain in the liquid, two other experiments were performed similar to the previous ones, except that the liquid was filtered immediately after all the ammonia had been added. The results of these experiments (35 and 36) point to a diametrically opposite conclusion, the more basic precipitate being obtained on the addition of the smaller amount of alkali.

The problem was then attacked in a different manner, a quantity of the sulphate was taken and precipitated

TABLE I.
Precipitation of Aluminium Sulphate with Ammonia.

| | Al ₂ O ₃ in the precipitate; that in the solution taken being 100. | Percentage of Al ₂ O ₃ in the anhydrous precipitate. |
|-----|--|--|
| 31. | 9 | 71.324 |
| 32. | 53 | 74.44 |
| 33. | 92 | 89.939 |
| 34. | 100 | 98.835 |
| 35. | 13.1 | 76.328 |
| 36. | 16.4 | 74.4 |
| 37. | 5 | 71.119 |
| 38. | 21 | 69.494 |
| 39. | 21 | 67.17 |
| 40. | 24 | 67.345 |
| 41. | 22 | 68.519 |
| 42. | 7 | 90.86 |

fractionally with ammonia. As it was found that the tendency of the precipitate to re-dissolve was considerably diminished by increasing the amount of water present, the solution here taken contained only 0.196 per cent of the sulphate instead of about 9 per cent., as in the previous cases. Even here, however, it is seen that a very considerable re-solution takes place, each precipitate given in the table being obtained by the addition of equal quantities of ammonia. In the last of these experiments (42) the alkali was present in slight excess. The results here obtained are curious, and when represented diagrammatically form a curve very similar both in general form and in position to those obtained from the experiments with sodium carbonate. The precipitate decreases at first in basicity, and after remaining for some time (during the precipitation of 45 per cent of the alumina) practically constant in composition, becomes more basic, till it consists of almost pure aluminium hydrate. But even the apparent constancy in composition of the precipitate in the experiments 39 and 40 cannot be assumed to be real, for both these precipitates may very well consist of some less basic substance mixed with one approaching in composition to that of experiment 38 on the one hand, and that of 41 on the other. Moreover, a sulphate containing about 67.25 per cent alumina does not correspond sufficiently closely to any definite chemical compound even to suggest its being such.

To a 49 per cent solution of alumina sulphate small portions of ammonia were added during the course of three days till the precipitate no longer re-dissolved. The solution, after having been filtered and set aside for four or five days, was found to have deposited a precipitate, which on analysis proved to contain 67.75 per cent of alumina. The filtrate continued to form a further deposit for some weeks longer.

These experiments, therefore, afford no confirmation whatever of Maus's statement that the sulphate Al₂O₃.SO₃ (containing 56.06 per cent of Al₂O₃) is obtained by the treatment of the normal sulphate with an alkali, nor do they tend to show that the precipitates which are really formed in this reaction are definite chemical compounds at all.

(To be continued.)

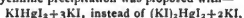
ESTIMATION OF ALKALOIDS BY POTASSIUM MERCURIC IODIDE.

By ALBERT B. PRESCOTT.

(Concluded from p. 125.)

Regarding the Iodomercurate Precipitation of Atropine, Mayer states* that the precipitate is (C₁₇H₂₃NO₃HI)₂HgI₂, "one-half the mercury of the test-liquor remaining in solution." He also makes the same remark again, thus:— "The compounds formed are hydriodates of the base with iodide of mercury; in consequence of which (?) a part of the mercury used for precipitation remains in solution." How it could be true that any part of the mercury used for precipitation remains in solution I am unable to understand, and qualitative tests indicate that it is not true. When Mayer's solution is added to alkaloid acidulate solution, not quite to complete precipitation of the alkaloid, and filtered, the filtrate yields no mercury beyond that trace due to the water solubility of the precipitate itself. Charging the filtrate with hydrogen sulphide, the solution is but slightly darkened, with no precipitate, and the same slight darkening is obtained with hydrogen sulphide in the final water washings of the precipitate. (The mercury of Mayer's solution is changed to precipitate of mercuric sulphide by action of hydrogen sulphide, and so is that of the alkaloid iodomercurate precipitates.) This evidence that no part of the mercury of the reaction is left in solution was obtained with quinine, morphine, aconitine, and atropine; and obtained, alike, with Mayer's solution as it is, and with Mayer's solution which had been saturated with mercuric chloride.

It certainly appears, then, that all the mercury of a potassium iodide solution, as well as all the iodide essential to the solubility of the same, enter into the precipitates with the alkaloids,—save only such traces as correspond to the solubility of these precipitates. In accord with this conclusion, regarding the iodide, the equation for strychnine precipitation was proposed with—



for Mayer's solution. Now, regarding the mercury—the element never in excess in our reagent—it has to be admitted, when we disprove Mayer's inexplicable statement for the atropine precipitation, that "one-half the mercury of the test-liquor remains in solution," we return to an apparent dilemma—a contradiction as to the ratio between atropine and mercury, as follows:—

C₁₇H₂₃NO₃ to Hg, from volumetric indications: Mayer, 0.0145; Dragendorff, 0.0125; Günther, 0.0193; the ratio varied by conditions; the precipitate somewhat soluble.

2C₁₇H₂₃NO₃ to Hg, from gravimetric indications: Dragendorff, 0.0375 alkaloid giving 0.0379; 0.0375 giving 0.0386; 0.0420 giving 0.0409, &c., quite uniform. (Precipitate : alkaloid :: 100 : 44.9.)

The above atomic ratio for volumetric use is that of 0.0145 atropine to each c.c. of the standard solution of 1.20,000th of C₁₇H₂₃NO₃ (289) to 1.20,000th of HgI₂+4KI (HgCl₂ 271 and KI 996.6). Mayer gave this, theoretical, as the working factor; Dragendorff reports[‡] a large number of results, pretty uniform for 0.0125 atropine to each c.c. of alkaloid, when the conditions were kept as follows: The dilution 350 to 500 parts for one of alkaloid; the Mayer's solution diluted with an equal bulk of water; the addition so slow that the precipitate may crystallise; the end of the reaction found by filtering a few drops and adding thereto a drop of the standard solution, and a correction made by adding 0.0005 grm. alkaloid for each c.c. of total solution. Günther, using a method of Dragendorff's, reports[§] 0.0193 to the c.c.

* CHEMICAL NEWS, vii., 161.

† *Ibid.*, 159.

‡ *Ibid.*, 159, 160.

§ Werthebestimmung, Seite 20. Also, in part, Dragendorff and Koppe, *Zeit. f. an. Chemie*, 6, 399, (1867).

‡ *Zeit. f. an. Chemie*, 5, 476 (1869).

Formation of Two Bibasic Acids, the Sebacic and Suberic, in the Distillation of Crude Fatty Acids in a Current of Superheated Steam.—A. Cahours and E. Demarcay.—The distillation of crude fatty acids in a current of superheated steam splits them up into saturated hydrocarbons, homologues of marsh-gas, in acids of the acetic group belonging to the normal series, and finally into two bibasic acids, homologues of succinic acid, i.e., the suberic and sebacic, compounds which are formed on submitting fatty acids of high molecular weights to oxidising agents.—*Comptes Rendus*.

For the atomic ratio found in gravimetric analysis of the atropine precipitate, having only half as much mercury to alkaloid as Mayer's volumetric ratio, I can only cite the experiments of Dragendorff,* but they seem to be sufficient. The atropine, in acidulate solution of 350 to 400 parts, is precipitated by a slight excess of Mayer's solution, the precipitate left twenty-four hours to subside, well washed, dissolved in alcohol, and this evaporated to dryness at 100° C. Eight trials are reported, with results ranging as quoted above. Mayer gives no data for the formula he states, $(C_{17}H_{19}NO_3)_4(HI)_2(HgI_2)_2$. The discrepancy, then, is to be acknowledged as an admonition to return to further investigation. The molecular formula of atropine obtains support from the late synthetic advances of Ladenburg;† but it is an alkaloid liable to decomposition, and consequent impurity, whereby our perplexity may have arisen. Also, the composition of the iodomercurate may change in being washed with water.

In the *Precipitation of Morphine as Iodomercurate*, it is well established that, when the dilution is 200 parts of acidulate solution for 1 part of alkaloid, each c.c. of Mayer's solution precipitates very nearly 0.020 of morphine crystallised, or 0.019 of morphine anhydrous. The alkaloidal crystals, $C_{17}H_{19}NO_3 \cdot H_2O = 303$, are constant on the water-bath, becoming anhydrous, $C_{17}H_{19}NO_3 = 285$, at 120° C. The factor 0.020 to the c.c. was given by Mayer, and is sustained by Kubly and Dragendorff, who make the proviso that the dilution should be 200 to 1.‡

In trials that I have made with crystallised morphine I have found the ratio of 0.020 to 1 c.c. to give results coming near to the quantity taken, but apt to fall a little below.§ The solubility of the precipitate must not be disregarded: in dilutions of 1 to 4000 the reaction does not appear. In the ratio of 0.0202 gm. crystallised morphine to the c.c. we have $\frac{303}{1000} = 0.303$ of $2C_{17}H_{19}NO_3 \cdot H_2O$ for $\frac{1}{1000}$ of $(HgI_2 + 4KI)$ in Mayer's solution; or 4 molecules of alkaloid for 3 atoms of mercury, indicating for the precipitate



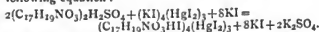
The following analyses of the precipitate were made by Messrs. Judson and Payne, following the method previously reported—the same used for strychnine.

| | Calculated from (C ₁₇ H ₁₉ NO ₃) ₄ (HI) ₂ (HgI ₂) ₃ | 1st. | Judson and Payne. 2nd. | 3rd. | Mean. | Calculated from (C ₁₇ H ₁₉ NO ₃) ₄ (HI) ₂ (HgI ₂) ₃ |
|------------|---|--------|---------------------------|------|--------|---|
| Iodine .. | 1270 | 42.13 | 42.6 | 43.0 | 42.43 | 1524 |
| Mercury .. | 600 | 19.92 | 17.5 | 18.0 | 18.40 | 600 |
| H of HI .. | 4 | 0.13 | — | — | 0.13 | 6 |
| Morphine.. | 1140 | 37.82 | — | — | 39.04 | 1140 |
| | 3014 | 100.00 | | | 100.00 | 3270 |

Groves (*loc. cit.*) obtained a mean of 42.27 per cent iodine and 22.74 per cent mercury, leaving 32.91 per cent morphine. His proposed formula was $C_{17}H_{19}NO_3 \cdot HgI_2$. In comparison, it may be noted that morphine forms $(C_{17}H_{19}NO_3)_4(HI)_2(HgI_2)_3$, $(C_{17}H_{19}NO_3)_4(HI)_2(HgI_2)_2$, and $(C_{17}H_{19}NO_3)_4(HI)_2$.

For morphine, then, gravimetric and volumetric experi-

ments, with the test for iodine in the filtrate, admit the following equation:—



In the *Quinine Precipitation*, it is stated that 1 c.c. of Mayer's solution precipitates 0.0108 gm. of anhydrous alkaloid. I am unable to cite any volumetric determinations in support of this ratio. The anhydrous alkaloid is obtained at 125° C. The crystallisation water of the sulphate is not uniform. The factor 0.0108 is $\frac{285}{2645}$ of two-thirds the molecular weight, 324, and indicates the molecule of the precipitate to be $(C_{20}H_{21}N_3O_2)_4(HI)_2(HgI_2)_2$. The percentages obtained by Messrs. Judson and Payne do not accord with this formula, whether we take two, three, or four of (HI). The following is a comparison of one of these formulae:—

| | Calculated from (C ₂₀ H ₂₁ N ₃ O ₂) ₄ (HI) ₂ (HgI ₂) ₂ | Judson and Payne. 1st. | 2nd. | 3rd. | Mean. |
|----------|---|---------------------------|-------|-------|--------|
| Iodine— | 1143 | 47.74 | 47.10 | 48.30 | 47.80 |
| Mercury— | 600 | 25.06 | 20.90 | 20.10 | 19.60 |
| H of HI— | 3 | 0.13 | — | — | — |
| Quinine— | 648 | 27.07 | — | — | — |
| | 2394 | 100.00 | | | 100.00 |

Some time since, a determination of the weight of iodomercurate precipitate of quinine, made by Messrs. Johnson and Lobb, was reported by the writer.* The quinine taken was dried, from the trihydrate, at 100° C. The precipitate was washed, and dried at 100° C. There were obtained—

| | |
|------|---|
| 1st, | from 0.280 of quinine, 0.801 of iodomercurate |
| 2nd, | " 0.280 " 0.824 " |
| 3rd, | " 0.280 " 0.812 " |
| Mean | " 1.000 " 2.900 " |

If we accept the proportion of 4.28 per cent of water retained in quinine hydrate dried on the water-bath (Allen,

referred to, *Ibid.*), we have 2.485 of precipitate from 1.000 of anhydrous quinine; or 33.01 per cent of alkaloid in the precipitate, against the 31.94 per cent of Judson and Payne. Groves† obtained a mean of 23.25 per cent of mercury, and 46.60 per cent of iodine, in the precipitate.

From the *Berberine Precipitate* Messrs. Judson and Payne obtained a mean of 4.17 per cent (40.8, 41.0, 37.7) of iodine, and a mean of 7.73 (7.5, 7.7, 8.0) per cent of mercury, leaving a mean of 52.10 per cent of alkaloid. In 1876 I reported‡ some results of work by Mr. Beach, giving very nearly 2 parts iodomercurate from 1 part of berberine. Excess of the standard solution did not vary the weight of the precipitate.

Certainly it is desirable to have analyses of these precipitates with direct estimations of the alkaloids in them, otherwise the question of hydration is unsettled. The quantity of precipitate made from a solution of a unit of

* "Wertbestimmung, Seite 24. Another report may be mentioned, one made by the present writer, in 1876, from the work of Mr. J. R. Little (*Am. Jour. Pharm.*, 48, 383; *Jahresbericht der Pharmacie*, 1876, 565). As the absolute purity of the alkaloid taken was not made certain, the object being that of approximate assay, I could not quote the results as important in this inquiry. In triplicate trial, 0.100 of atropine gave 0.170 of precipitate. The precipitate was simply water-washed and dried.

† *Deut. Chem. Ges. Ber.*, 12, 941, 944.

‡ "Wertbestimmung starkwirkender Drogen," S. 86. *Zeit. Analyt. Chem.*, 6, 321. Results as follows:—

| | |
|------|--|
| 1st. | 0.0224 cryst. morphine in the c.c. in feebly acid sol. |
| 2nd. | 0.0221 " " " " strongly " |
| 3rd. | 0.0191 anhyd. " " " " feebly " |
| 4th. | 0.0205 " " " " strongly " |

§ The writer's report on Mercurimetric Processes for Opium, *Proc. Am. Pharm. Assoc.* (1878), 26, 512; *Jour. Chem. Soc.* (1880), Abstracts, 1.

* *Am. Jour. Pharm.*, 49, 482 (Oct., 1877); *Jahresbericht der Pharm.*, 1877, 419; *Jour. Jour. Trans.*, 131, 5, 407.

† *Jour. Chem. Soc.*, 1, 101.

‡ *Am. Jour. Pharm.*, 48, 385; *Jahresbericht der Pharm.*, 1876, 524.

alkaloid becomes an uncertain datum in most cases, owing to a degree of solubility of the precipitate.

Some determinations of the proportions of iodide and mercuric salt needful for solutions were made by Mr. Hugo Lupinski,* and should be here reported. Four twentieth-normal solutions were made, as follows:—

No. 1.—Mercuric chloride, 13.55; potassium iodide, 33.22; water to 1 litre. $HgCl_2 + 4KI = HgI_2 + 2KI + 2KCl$. Some red mercuric iodide remained undissolved. This dissolved when heated, and crystallised on cooling.

No. 2.—Mercuric chloride, 13.55; potassium iodide, 33.22; potassium bromide, 2.9825; water to 1 litre.

$HgCl_2 + 4KI + 4KBr = HgI_2 + 2KI + 4KBr + 2KCl$. Complete solution required heat, and on cooling there was a crystalline deposit of red iodide of mercury.

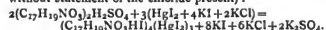
No. 3.—Mercuric chloride, 13.55; potassium iodide, 33.22; potassium bromide, 5.965; water to 1 litre.

$HgCl_2 + 4KI + KBr = HgI_2 + 2KI + KBr + 2KCl$. Dissolved readily, and did not deposit on standing four weeks.

Solution No. 3 was used, with the idea that it furnished potassium mercuric iodide of the more stable composition of $(KI)_2HgI_2$, with no excess of iodide, and in a permanent solution. It was thought that, with most alkaloids, the bromide would not react at all.

Using this solution, No. 3, Mr. Lupinski made a diligent search for an indicator of the end of the reaction, with alkaloids:—(1) A paper wet with saturated mercuric chloride and dried was used—to reveal the presence of an excess of the standard solution in estimation of alkaloids. The indicator worked well, except that it was not delicate enough. (2) A solution of potassium and ammonium hydrates, to give the mercurammonium iodide, when excess of the reagent was attained, with alkaloid acidulous solutions. The alkali hydrates react with the alkaloid precipitates, and therefore do not serve. (3) A solution of iodic acid and starch, to show when excess of soluble iodide had been attained. This, too, reacted with the precipitates, and was inoperative.

A proposition was made by Mr. Mayer† to find the end of the reaction by adding excess of the Mayer's solution, and then "without filtering" titrating back with tenth-normal solution of silver nitrate, using normal chromate of potassium as an indicator in the common way. Each c.c. of the standard potassium mercuric iodide to require 4 c.c. of the corresponding silver solution. Mr. Lupinski‡ calls attention to the essential defect in this plan, that it disregards the accumulation of the potassium chloride of Mayer's solution during the precipitation of alkaloids. Also, the excess of potassium iodide would interfere in the same way. The erroneous results of titrating back with Mayer's solution may be placed before the eye by an equation for the morphine precipitation (given before without statement of the chloride present):—



With no excess of the Mayer's solution, there are still $8KI + 6KCl$ to titrate back with the silver solution. Mr. Mayer offers this use of the silver solution, "where no colouring matters, or substances affecting nitrate of silver, are present." On trial some time ago I found that some of the alkaloid idiomercurate precipitates gradually decompose silver nitrate in solution by contact at common temperatures.—*American Chemical Journal*.

Oxygen.—It is said that MM. Brin have greatly improved Boussingault's process for the manufacture of oxygen by alternately peroxidising and re-oxidising barium oxide. The material employed after being re-used 400 times was found not to be deteriorated. MM. Brin calculate on being able to supply oxygen on the large scale at 12 to 15 centimes per cubic metre.—*Les Mondes*.

* "Graduation Thesis," Univ. Mich., 1878.
† *Chemical News*, vol. vii., p. 159.
‡ "Thesis," before cited.

MAGNESIUM AND SODIUM THIOCARBONATES.

By I. TAYLOR, Christ Church, Oxford.

Magnesium Thiocarbonate may be prepared in the following manner:—A strip of magnesium ribbon is coiled about a piece of platinum foil, which is placed in a flask, and covered half with carbon disulphide, the remaining half with water. In a few hours the water acquires a light yellow tint, which deepens in two or three days to a bright golden yellow. Magnesium thiocarbonate is formed, carbon monoxide and hydrogen gases being at the same time evolved, probably according to this equation—



The same decomposition occurs, but more slowly, if a spiral of magnesium ribbon is used without the platinum foil.

Sodium Thiocarbonate may be obtained by decomposing water, in presence of carbon disulphide, with sodium amalgam. Carbon disulphide is placed in a flask and water added, then a quantity of sodium amalgam. The flask is shaken well. Sodium thiocarbonate is rapidly formed, carbon monoxide and hydrogen gases being evolved, probably thus—



LOCH KATRINE WATER.

The annual report on Loch Katrine water, prepared by Professor E. J. Mills, D.Sc., F.R.S., of the Young Laboratory of Technical Chemistry, Anderson's College, has been published. The report refers to the twelve months from March, 1881, to February, 1882, inclusive. The composition is represented in parts per 100,000; these numbers can be converted into grains per gallon by multiplying by 0.7. The mean composition and mean departure therefrom are as follow:—

| | Com- position. | Mean departure. | Mean departure per cent. |
|----------------------------|-------------------|--------------------|--------------------------------|
| Total solid impurity | 3.001 | 0.073 | 2.4 |
| Organic carbon | 0.140 | 0.009 | 6.4 |
| Organic nitrogen | 0.017 | 0.003 | 11.1 |
| Ammonia | 0.000 | 0.000 | 0.0 |
| Nitric nitrogen | 0.008 | 0.001 | 12.5 |
| Total combined nitrogen .. | 0.025 | 0.003 | 12.0 |
| Chlorine | 0.03 | 0.024 | 3.8 |
| Hardness (total) | 0.99 | 0.08 | 8.0 |
| Mean .. .. | .. .. | .. .. | 7.03 |

By way of contrast the corresponding figures for last year are appended:—

| | Com- position. | Mean departure. | Mean departure per cent. |
|----------------------------|-------------------|--------------------|--------------------------------|
| Total solid impurity | 2.938 | 0.071 | 2.4 |
| Organic carbon | 0.133 | 0.020 | 14.9 |
| Organic nitrogen | 0.017 | 0.002 | 13.7 |
| Ammonia | 0.000 | 0.000 | 0.0 |
| Nitric nitrogen | 0.007 | 0.001 | 8.9 |
| Total combined nitrogen .. | 0.023 | 0.003 | 11.0 |
| Chlorine | 0.018 | 0.023 | 3.7 |
| Hardness (total) | 1.01 | 0.08 | 7.9 |
| Mean .. .. | .. .. | .. .. | 7.8 |

The average percentage variation during the last six years has been successively 56, 27, 13, 6.9, 7.8, 7.03.

Total Solid Impurity.—This was at a minimum (2.89 in July), and a maximum (3.12) in December. Its general character was such as to impart a pale brown colour to the water, with only a slight turbidity. Its average amount has been a little more than last year.

Organic Carbon.—This has increased 0.007 since last year. Minimum (0.127) in June; maximum (0.151) in February.

Organic Nitrogen.—Minimum (0.012) in July; maximum (0.027) in March.

Ammonia.—The continued entire absence of ammonia is a remarkable circumstance in connection with urban supply.

Nitric Nitrogen.—This element maintains its smallness and almost constancy of amount.

Total combined Nitrogen.—This was somewhat more than last year. Minimum (0.019) in July; maximum (0.034) in March.

Chlorine.—Chlorine continues to increase, being about 2 per cent higher than in the preceding annual period. Maximum (0.7) in February.

Hardness.—The saline compounds which impart hardness to this water are nearly the same in amount as last year. Maximum (1.2) in February; minimum (0.71) in April.

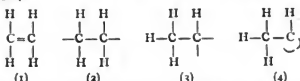
Dissolved Gases.—The amount of these has been once determined during the year, in January. The results are stated in volumes per cent.

| Carbon dioxide. | Oxygen. | Nitrogen. | Total. |
|-----------------|---------|-----------|--------|
| 0.02 | 0.30 | 1.46 | 1.78 |

The carbon dioxide was remarkably low, and the oxygen rather low.

Temperature.—The minimum was 4° C. (=39.2° F.) in March. Maximum was 12.6° C. (=56.5° F.) in August. Mean, 8.6° C. (=47.5° F.).

ceptions a given radicle always manifests either an even or uneven valency, and not an even valency at one time and an uneven valency at another. These views are at the basis of our present system of writing developed rational formulæ. As an outcome of this, we have the division of compounds into atomic and molecular: the first consisting of those bodies for which rational formulæ may be constructed on the basis of certain hypothetical conceptions of the valency of the constituent elements; the second comprising all those for which rational formulæ cannot be thus constructed. The author then considered the hydrocarbons, as this class of bodies plays such an important part in modern theoretical chemistry. Our views of the constitution of the hydrocarbons are based on the assumption that in them carbon is uniformly a tetrad, and that methane, CH_4 , is to be represented by a symmetrical formula. It appears to be generally agreed that we are to regard the hydrocarbons of the paraffin, or $\text{C}_n\text{H}_{2n+2}$ series, as the parent series from which all other series of carbon compounds are more or less directly derived. As to the series C_nH_{2n} , the first term of this series is C_2H_4 . Now four formulæ may be assigned to C_2H_4 —



Now all attempts to produce a hydrocarbon of unsymmetrical constitution, as 3 and 4, have failed, and it has become almost a dogma to accept No. 1 as the correct formula. Whether we assign the formula 1 or 2 to ethylene, there can be but little doubt that only one of these forms of combination is possible, for we only know one ethylene. The first term of the $\text{C}_n\text{H}_{2n-2}$ series, acetylene, C_2H_2 , has by general consent the formula corresponding to No. 1 of ethylene. Acetylene has the remarkable property of forming metallic derivatives, and it seems that only one of the hydrogen atoms becomes displaced. The author then considered the $\text{C}_n\text{H}_{2n-6}$ series, which includes, besides the benzene series, dipropargyl, which behaves like an acetylene, but can exchange two atoms of hydrogen for metallic radicles, and has a considerably higher heat of combustion than benzene. The various formulæ proposed for benzene were then discussed, the least objectionable being the well-known formula of Kekulé; but on the whole the author prefers the formula first suggested by Lothar Meyer—



in which the carbon atoms have free affinities, and proposes a simple hexagon as the most satisfactory symbolic embodiment of our knowledge of benzene and its compounds. Lossen and Brühl have from somewhat different arguments also advocated this view. Lossen, moreover, states that in our present state of knowledge it is impossible to express in a rational formula more than this, viz., with what other atoms each individual atom in the molecule is directly united. Lossen defines valency of an atom as the number expressing how many atoms are directly combined with it. In this sense valency is variable; but experience shows that every polyad atom has a highest or limiting value, and, as the lower values are all included in it, in this sense valency is constant. The author then refers to the views of J. Thomsen on the constitution of benzene, and gives various reasons why as a chemist he dissents from his conclusions. Prof.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 16, 1882.

Prof. H. E. Roscoe, President, in the Chair.

The following certificates were read for the first time:—W. J. Kemp, P. W. Squire, L. Taylor. During the evening a ballot was held, and the following gentlemen were declared by the Scrutineers, Drs. Plimpton and Thorne, duly elected Fellows of the Society:—H. S. Billing, J. Brown, H. H. Crawley, T. Donnelly, U. K. Dutt, W. Fowler, N. Graham, A. Hartley, A. Hill, R. Mar, J. T. Smith, F. Vacher.

Dr. ARMSTRONG read a paper "On Valency," with special reference to methods of writing rational formulæ, and the existence of so-called molecular, as distinct from atomic, compounds. The definition of valency, at present most in accordance with the views of the majority of chemists, is probably the following:—The valency of a radicle is its combining or displacing power in terms of hydrogen atoms, a radicle being monad, dyad, triad, or tetrad, according as it is capable of combining with or displacing one, two, three, or four atoms of hydrogen, or the equivalent amount of some other simple or compound radicle. Some chemists maintain that a given radicle has a fixed valency; others that valency is variable; but as the latter for the most part consider that the latent affinities of an unsatisfied radicle in some way neutralise each other, the difference is to a great extent one of words. It is remarkable that those who hold atomicity to be variable have hesitated to confer higher functions, for example, than pentadic on phosphorus, or hexadic on sulphur, and that only one element belongs to the class of octads. It appears to be very generally held that the valency of a radicle is not necessarily determined by reference to its compounds with monad elements, but that its compounds with polyad elements are also available. We are also accustomed to the statement that with few ex-

Hartley's results are also, in the opinion of the author, not conclusive as to the constitution of benzene. In conclusion the author briefly considered the question of double salts, as $K_2P_2Cl_6$, K_2FeCl_4 , &c. The latter compound is undoubtedly a ferrous compound, but the chlorine might be polyvalent, and so hold the potassium on to the iron. Some of these so-called molecular compounds are more stable than the simpler atomic compounds. Thus $PtCl_4$ is a very unstable substance compared to K_2PtCl_6 ; and, again, $HClO_4 \cdot 2H_2O$ is more stable than $HClO_4$.

Dr. WRIGHT drew attention to a symbol for benzene, which, though resembling Ladenburg's, was essentially different. It represented the atoms of carbon as collected at the corners of a triangular prism. As regards the double salts it seemed to him that the polyvalency belonged to the chlorine rather than to the metal, and that the formulæ might be written very similarly to those of the carbonates.

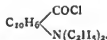
Mr. FISHER said that Dr. Armstrong, in discussing the formula of benzene, hardly seemed to have the courage of his convictions. The criterion of valency was the power of an element to combine with H; thus in acetylene carbon is a dyad, in ethylene a triad, &c. There was great danger of reasoning in a circle; if hydrogen be taken as the unit of valency, then in H_2O oxygen is a dyad, but in a compound like NO we have lost all connection with hydrogen, and it is best to say N and O are in this compound both monads, and so in benzene carbon is a triad. The double salts seemed in many cases to be truly atomic compounds. Thus if chlorine be passed into a solution of pure $PbCl_2$ no combination takes place, but if HCl or KCl be present a compound containing $PbCl_4$ is at once formed, and these compounds are quite stable, and are just as truly atomic compounds as $PbSO_4$.

The PRESIDENT said that the more we considered the subject the more difficult it seemed to come to a conclusion, either as to fixed or variable valency, and, as Dr. Williamson pointed out, valency seemed to be a function of temperature. In some respects valency had been of great use, as, for instance, in connection with Mendeljeff's law.

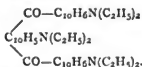
"On the Preparation of Diethyl-naphthylamine," by B. E. SMITH. The author prepared this substance by the action of ethyl-bromide upon naphthylamine, at 100° to 120° ; it is a pale straw-coloured oil, boiling at 290° . By the addition of hydrochloric acid the hydrochloride was obtained, very soluble in hot water. Nitroso-diethyl-naphthylamine was also prepared. The properties and analyses of these bodies are given in the paper.

"On the Action of Sulphuric Acid upon Diethyl-naphthylamine at High Temperatures," by B. E. SMITH. A base $[C_{10}H_6N(C_2H_5)_2]_2$, crystallising in needles, was formed—an acid having the formula $C_{10}H_6N(C_2H_5)_2 \cdot SO_3OH$ was also studied.

"On the Action of Phosgene Gas upon Diethyl-naphthylamine," by B. E. SMITH. Three colourless crystalline bodies were obtained. Two were isomeric, having the formula—



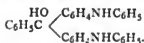
The formula of the third is—



"On some Constituents of Resin Spirit," by G. H. MORRIS. The author gives a *résumé* of previous researches on the subject. It has long been known that the lower fractions of resin spirit yield, on standing for some time, especially if loosely stoppered, a crystalline substance. These crystals have been analysed by Tichborne, Mills, and Anderson. The results of the author agree with those of Anderson. The crystals have the formula

$C_7H_{14}O_2H_2O$. The anhydrous body, $C_7H_{14}O_2$, was also analysed; its vapour density, by Hofmann's method, was 63.6, theory requiring 65. These crystals are formed most plentifully by the fraction of resin spirit, boiling at 100° to 105° . The author succeeded in separating a hydrocarbon which had the formula $[C_7H_{12}]_2$, of diheptene. Vapour density found 94.23. It is from this hydrocarbon that the above crystals are formed. The author has studied the action of nitric acid on heptene; the products are CO_2 , formic, acetic, butyric, and succinic acids, and a small quantity of dinitro-heptylene. The action of nitric acid, of acetic anhydride, and of bromine on the crystals has been investigated. The author concludes that the hydrocarbon heptene is probably methyl-propyl-allylene.

"Contributions to the Chemical History of the Aromatic Derivatives of Methane," by R. MELDOLA. In 1877, by the action of benzyl-chloride upon diphenylamine, the author obtained a viscid oily body, which, by oxidation with arsenic acid, formed a green colouring-matter, "viridin." Since that time the author has proceeded with the investigation of this reaction. The colouring-matter is the hydrochloride of a new base—



The diphenylamine green is produced by a reaction analogous to that by which malachite green is produced from its base. The base is thus diphenyl-diamido-triphenyl-carbinol. The diphenylamine green can be obtained more advantageously by employing benzo-trichloride. The salts of diphenylamine green are mostly insoluble in water. The author has examined the optical properties of the green, and the sulphonic acids produced by the action of sulphuric acid. He also discusses the constitution of the green and its relations. The author has studied some other products formed by the action of benzyl-chloride upon diphenylamine in the presence of zinc chloride. One of the products was a white pulverulent substance, phenyl-amido-diphenyl-methane, $C_{19}H_{17}N$; another, obtained by increasing the quantity of benzyl-chloride, was probably benzyl-phenyl-amido-diphenyl-methane, $C_{24}H_{23}N$. The action of benzyl-chloride upon aniline was also studied. As a general result it appears that when benzyl-chloride acts upon amines at a high temperature, or at a lower temperature in the presence of zinc chloride, the hydrogen of the aromatic nucleus is attacked; and in cases where the amido-group contains any replaceable hydrogen, or other radicle, substitution likewise takes place in the group, with the formation of substituted amido-derivatives of diphenyl-methane.

"On Pentathionic Acid" (Part II.), by WATSON SMITH and T. TAKAMATSU. The authors reply to some length to the criticisms of Lewes, Spring, and Curtius, and give the results of some further investigations of the subject, on the effect of neutralising a solution of pentathionic acid in dilute alcohol with barium carbonate, and on the effect of solutions of alkalis on pentathionic acid solutions.

The Society then adjourned to April 6th (Anniversary Meeting, March 30th), when the following papers will be read:—"Observations on the Action of Acetylic Chloride on Fumaric Acid," by W. H. PERKIN; "Note on a Convenient Apparatus for the Liquefaction of Ammonia," by J. E. REYNOLDS; "Transformation of Urea into Cyanamide," by H. J. H. FENTON; "Some Arguments in favour of Ladenburg's Prismatic Formula of Benzene," by W. K. DUTT.

THE AMERICAN CHEMICAL SOCIETY.*

The February meeting of the American Chemical Society was held on Friday evening, February 3rd.
Dr. Orazio Lugo was elected a regular member.

* Communicated by M. Benjamin, Ph.D., F.C.S.

The first paper of the evening was "On Crystallised Anhydrous Grape Sugar," by Dr. ARNO BEHR.

It was customary in the preparation of the anhydrous grape-sugar to crystallise it out from an alcoholic solution, particularly from that of methylic alcohol, but Dr. Behr was led to believe it possible that a simpler method could be devised. After some experimenting, he found that it could be obtained from the ordinary hydrated solution. A solution with 12 to 15 per cent of water gave the best results. In the description of its properties, Dr. Behr stated that when dried in a current of dry air the crystallised sugar would not retain more than two or three per cent moisture, its reaction is neutral, its melting-point is between 141° and 145° C. When tested by the polariscope it showed bitoration. Dr. Behr then referred briefly to its economic uses, how by its cheapness it would be largely used by the confectioner, the druggist, and by those who manufacture wines. He also stated that as regards its sweetening qualities, instead of requiring twice as much or more to make it equal to cane sugar, he had found that one and two-thirds as much was sufficient.

Mr. NELSON H. DARTON followed with a short paper "On the Precipitation of Tannic Acid as Tannate of Copper." This paper was a supplementary description of Mr. Darton's method, already read before the Society. It consists in the precipitation of tannic acid by the ammonia sulphate of copper. The precipitate was tested for ammonia with negative results, and therefore it was contended by Mr. Darton that the precipitate was composed of copper tannate and not the double salt as has been elsewhere claimed.

The final paper of the evening was by Dr. E. WALLER, of the School of Mines, Chemist to the New York Board of Health. Its title was "On the Water Supply of New York City." The object of this paper was to contradict certain statements made by Prof. Leeds in his recent paper read before the Society and published in the CHEMICAL NEWS. Dr. Waller produced the analysis made by Dr. Booth in 1843, then by Dr. Chilton, running between the years 1843 and 1859. Dr. Chandler's results from analysis in 1869-72, and finally his own, which have been regularly reported since 1872. These latter were represented by means of curve lines on diagrams which showed exactly the amount of each constituent for any time during the past nine years. These we may condense and show by the following table:—

| | PARTS IN 100,000. | | |
|-------------------------------------|-------------------|----------|----------|
| | Maximum. | Minimum. | Average. |
| Mineral matter | 8.44 | 3.22 | 5.702 |
| Org. and vol. matter .. | 4.40 | 0.04 | 1.67 |
| Total solids | 11.07 | 4.80 | 7.38 |
| Hardness | 5.40 | 1.88 | 3.21 |
| Oxygen by permanganate method | 0.383 | 0.047 | 0.180 |

The results obtained by Professor Leeds in comparison with those showed from the above table were in several instances quite different. Thus, Professor Leeds finds the total solids to be higher than any result obtained by the New York Board of Health during the past fourteen years. In other determinations similar discrepancies were shown by Dr. Waller. The statement that the Croton water was contaminated by tanneries and other factories was objected to as incorrect, the tanning having long since ceased on account of the scarcity of trees. A statement from the Chief Engineer of the Water Department was read, in which he claimed that the water shed of the Croton River was the cleanest of any from which the supply of drinking water was obtained, either in this country or abroad. The population of the country through which the Croton flows does not exceed 20,000 inhabitants, or about one person to every ten acres. In comparison with other cities, the number of inhabitants to the square mile residing along the water shed of Croton was stated to be extremely small, thus:

| | Population to the Square Mile. |
|--|--------------------------------|
| London | 270 |
| Boston | 229 |
| Brooklyn | 119 |
| Schenectady { Drawing their supply from } Conoes { the Mohawk River } | 103 |
| West Troy | 77 |
| Albany | 86 |
| Poughkeepsie { Supplied from Hudson } Hudson { River. } | 65 |
| New York | 36 |
| Rochester | |

By arguments such as the above, Dr. Waller maintained that the conclusions reached by Professor Leeds were erroneous. In the discussion that followed certain of Dr. Waller's modes of analysis were criticised by Dr. Endemann, but his remarks were merely on a side issue, and had no bearing on the results.

NOTICES OF BOOKS.

Experimental Chemistry for Junior Students. By J. EMERSON REYNOLDS, M.D., F.R.S., &c. Part II.—Non-metals. London: Longmans and Co.

THE author begins this portion of his treatise with a series of experiments intended to show the properties of atmospheric air, at the same time remarking that air is not a chemical compound, but a mere mechanical mixture. He classes carbon dioxide, water, ammonia, and ozone as "impurities,"—a term of doubtful legitimacy in case of a mixture. In the succeeding chapter he passes on to experiments in illustration of the compounds of nitrogen. These experiments must be pronounced easy, simple, and well-chosen. After dealing with the halogens Dr. Reynolds passes on to fluorine, and here he describes a very interesting experiment, which we never remember having seen mentioned in an elementary treatise. He directs sheep's teeth, powdered, to be heated in a test tube with concentrated oil of vitriol, when the tube will be found distinctly corroded by the hydrofluoric acid liberated from the enamel of the teeth. Silicon and carbon are next taken in hand, the hardness of water being introduced under the latter as due, in many cases, to dissolved carbonates. Then follow experiments on coal-gas and on the nature of flame. Sulphur, boron, and phosphorus complete the series of elements introduced. As an Appendix is given a systematic process of testing for the common acid radicals.

That the phenomena referred to in this little book are described correctly cannot of course be questioned, but it is almost, if not altogether, impossible to present the elementary facts of chemistry in any novel light.

A Systematic Handbook of Volumetric Analysis, or the Quantitative Estimation of Chemical Substances by Measure, applied to Liquids, Solids, and Gases. By FRANCIS SUTTON, F.C.S. Fourth Edition. London: J. and A. Churchill.

It is interesting to compare the present edition of Mr. Sutton's work with its original form in 1863. In bulk it has been more than doubled, owing to the many important additions which have been found necessary. In the book before us we find, e.g., instructions for the volumetric analysis of compounds of aluminium, calcium, cerium, uranium, vanadium, cobalt, and nickel; of raw kinate; of fruit-juices; soaps; of phosphoric and silicic acids in natural waters, two constituents often ignored by analysts, though the presence of the former may often supply important evidence concerning animal pollution. The

volumetric analyses of gases is treated at considerable length, and with much care.

Among alkalimetric indicators the reader will find an account of the properties and advantages of Poissier's Orange 3, Tropæolines oo and ooo, Phenol-phthaleine, Eosine, and Coralline. The author gives the preference to the first of these bodies, as being unaffected by carbonic acid and sulphuretted hydrogen, and acting well with ammonia. The tropæolines have in the main similar properties, and are equally applicable without the aid of heat, but are somewhat less sensitive. Phenol-phthaleine is useless in presence of carbonic acid and ammonia, whilst coralline has no well-marked superiority over litmus.

Many of the methods recommended in the earlier editions have been greatly modified, or omitted in favour of processes more accurate and convenient. Thus under Indigo the method of Schlumberger is omitted, as also the permanganate process. In their stead we find the potassium ferricyanide process (Ullgren's), whilst the bichromate process—formerly known as Penny's—is now attributed to MacKinlay, and is described at greater length, particular attention being given to the difficult point, *i.e.*, the recognition of the end of the reaction.

The process given for the volumetric determination of soap is based upon Clark's universally-known method for finding the hardness of water.

As regards sulphuric acid Mr. Sutton strongly urges the claims of the volumetric as preferable to the gravimetric method. He endorses the opinion of Teschemacher and Smith "that the estimation of sulphur and sulphuric acid by the weight of barium sulphate obtained is, and can be, correct only by accident, and when the adherent impurity happens exactly to counterbalance the barium sulphate dissolved." (See CHEMICAL NEWS, xxiv, p. 61 to 66).

The volumetric determination of phosphoric acid is discussed in detail. The author holds that two methods only are admissible—that by uranium, and Stolba's method, where the phosphoric acid is separated as ammonium-magnesium phosphate, with subsequent titration by means of standard acid. Among the ways of removing the phosphoric acid from mineral, and especially manual, solutions, the preference is of course given to the molybdic process, though the methods of Graham, Reynoso and Girard, Chancel and Joulie are described as useful under certain conditions. The lead-process (Mohr's) is omitted. Under this head Mr. Sutton makes some severe, but not unmerited, comments upon the so-called "high" and "low" analysts, and upon such as profess to work by secret methods. We may here ask whether it is not unprofessional to patent an analytical process—a case which has happened, we understand, more than once.

Turning to the analysis of chrome-iron we find, in addition to the modified process of O'Neill, the methods of Britton and Sell.

Under Copper we find the same processes as in the first edition, with the addition of that of Weil (by means of stannous chloride) and of Steinbeck's instructions for the technical examination of cupreous minerals. Carnelley's colorimetric process is recommended for slags and poor ores.

Manganese, in its various states, forms the subject of an extensive chapter. There are instructions for the volumetric analysis of ferro-manganese and spiegeleisen, steels, mangiferous slags, &c. For the technical examination of scraples of manganese-ores, as used for the manufacture of bleaching-powder, we find the processes of Fresenius and Bunsen, Pickering's method for Weldon mud, as also the oxalic acid and the iron methods. In case of commercial samples of the black oxide, a careful determination of moisture is recommended as necessary.

Mr. Sutton says no more than the exact truth when he declares that his work has become the standard text-book on the subject wherever the English language is spoken, and the present edition will, we doubt not, find increased favour in proportion to its greatly increased completeness and utility.

CORRESPONDENCE.

READING BURETTES.

SIR,—Mr. James H. McMahon recommends (CHEMICAL NEWS, vol. xlv., p. 109) his recently invented method of correct reading off of burettes; but allow me to state that this reflex method has already been mentioned in Mohr's "Titrimethode," p. 10, published in 1862.—I am, &c.,

DR. ALFRED WOLF.

Wakefield, March 15, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 10, March 6, 1882.

Normal Carbonic Acid of the Atmosphere.—M. Dumas.—The author whilst proposing further observations in different parts of the world with the view of determining the fluctuations of the atmospheric carbonic acid, remarks that the antagonistic action of plants and of animals is probably a less important factor than the emission of carbonic acid from volcanic fissures and craters, and its fixation in the form of calcium carbonate in the seas.

Experiments made with a Faure's Secondary Battery.—MM. Allard, Le Blanc, Joubert, Potier, and Tresca.—The authors find in their experiments that the use of the accumulator costs 0.40 of the work furnished by the dynamo-electric machine which had produced the current, or in other words, 0.40 of the electric work which would have been available without its intervention. It is but justice to add that in many cases this loss would be compensated by the convenience of having at hand and entirely at disposal an abundant source of electricity. The battery forms, moreover, a powerful regulator.

Double Decompositions of the Haloid Salts of Mercury by the Hydracids and by the Haloid Salts of Potassium.—M. Berthelot.—A series of thermo-chemical determinations, the results of which are expressed in tables.

A New Pump for the Compression of Gases.—M. Cailliet.—This memoir cannot be usefully reproduced without the accompanying illustration.

A Rapid Method for Determining the Density of Gases.—G. Chancel.—This paper requires the two accompanying illustrations.

Hydrodynamic Experiments: Direct Imitation by Liquid Currents of the Reciprocal Action of Electric Currents.—C. Decharme.—A continuation from the memoirs inserted in the *Comptes Rendus*, February 13 and 20, 1880. The author continues tracing out analogies between currents of water and electric currents.

The Retrogression Produced by the Electric Effluve in the Transformation of Oxygen into Ozone.—P. Hautefeuille and J. Chappuis.—The transformation of oxygen into ozone during the electrification of the gas is limited; there is established an equilibrium between the production of ozone by the effluve and its spontaneous destruction, which is always rapid at the temperature to which the passage of electricity raises gases. The quantity of heat coming from this exothermic transformation increases as the proportion of ozone, and is added to the quantity of heat due to the rain of fire, or to the effluve. We may then easily conceive that it will occasion a destruction rapid enough to limit the transformation of the

oxygen, or even provoke periodically a decrease in the proportion of ozone. The author's experiments prove that the conversion of ozone into oxygen is the consequence of the liberation of heat, which accompanies the spontaneous destruction of ozone when raised to the unknown temperature of the effluve.

Certain Phosphates Neutral to Litmus.—MM. E. Filhol and Senderens.

Lutocrine, an Isomer of Orcine.—G. Vogt and A. Henninger.—This compound is described in a sealed paper which the authors deposited in 1875, and which has now been opened at their request. Lutocrine is obtained on treating mono-bromated para-cresylol with potassa. It crystallises in very small colourless needles arranged in hemispheric masses. It melts at 104° to 105°, and dissolves easily in water, alcohol, and ether, but less readily in benzol and chloroform. It differs from orcin by its crystallisation, its melting-point, and its coloured reactions. In presence of alkalis, lutocrine, on exposure to the air takes a blood-red tint; acids turn this colour to a yellow, but alkalis restore it. Chloride of lime gives a very intense and stable blood-red; potassium permanganate colours it also a bright red. With ferric chloride it takes a deep dirty green, and gives a reddish brown precipitate which does not contain iron. If treated with ammonia in presence of air it is converted into lutorceine, which has a brownish yellow colour, and is turned by acids to a pure yellow. This lutorceine dyes yellow.

Soluble and Insoluble Modifications of the Ferment of Gastric Digestion.—A. Gautier.—The author, referring to M. Béchamp's memoir in the last number of the *Comptes Rendus*, on the "Gastric Microzymas and their Digestive Power," combats the view that the agents of digestion are organisms. He shows that the action of the corpuscles of the gastric juice is not hindered any more than that of pepsine by considerable doses of hydrocyanic acid (1-200th), which even in much smaller doses proves fatal to vibriones and all figured ferments.

Bulletin de la Société Chimique de Paris.

Tome 37, No. 1, January 5, 1882.

Formation of Benzhydryl-propionic Acid.—E. Burcker.—This compound is obtained by the action of succinic anhydride upon benzol in presence of aluminium chloride. It is a higher homologue of the phenyl-glycollic and phenyl-lactic acids.

Preparation of Triphenyl-methan.—C. Friedel and J. M. Crafts.—The authors propose as the best proportions 1000 parts benzene, 200 chloroform, and 200 parts aluminium chloride, the latter being added in four or five portions, to avoid a too violent reaction.

Synthetic Formation of Phenyl-propyl-aceton.—E. Burcker.—The author has formed this compound by causing butyryl chloride to act upon benzol in presence of aluminium chloride.

No. 2, January 20, 1882.

The Forms of Calcium Carbonate.—M. Schützenberger.—The author has observed that a solution of this salt in water containing much carbonic acid yields on boiling arragonite, whilst in presence of a small quantity of carbonic acid there are obtained hexagonal stars with a centre in the form of a sphere. Artificial calcium carbonate (arragonite) if heated to 200° to 300° gives, when raised to the boiling-point of sulphur, an escape of carbonic acid, which ceases in a few minutes.

Presence of Free Fluorine in the Fluorspar of Wölsendorf.—O. Loew.—The author proves that the odour of this mineral is due to free fluorine, furnished by the decomposition of a cerium perfluoride, analogous to manganese perchloride, and splitting up at low temperatures into a fluoride and free fluorine.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. 13, No. 13.

On Trioxymaleic Acid.—S. Tanaber.—Potassium maleate is oxidised by means of the gradual addition of dilute permanganate to the refrigerated solution.

Constitution of Isomeric Hydrocarbons.—Julius Thomsen.—The author is of opinion that the constitution of such bodies may be studied thermo-chemically.

Thermo-chemical Researches on Cyanogen and Hydrocyanic Acid.—Julius Thomsen.—The author pronounces the value for the formation heat of hydrocyanic acid, as determined in the moist way by M. Berthelot, perfectly useless.

On Citric Acid.—G. Andreoni.—The author is attempting the synthesis of citric acid by a process quite distinct from that of MM. Grimaux and Adam.

Behaviour of Starch with Glycerin.—K. Zulkowsky.—Starch is soluble in glycerin at about 130°, and if the mixture is heated to 190° the starch is found to have passed into the soluble modification more or less completely according to its origin. Potato-starch is converted most readily, then wheat-starch, whilst rice-starch is slowly and sparingly acted upon.

Synthesis of Meta-isopropyl-toluol.—A. Ziegler and W. Kelbe.—The cymol formed from isopropyl-iodide and toluol in presence of aluminium chloride, and the cymol of resin-oil, are meta-isopropyl toluol.

On Bromnitro-, Nitro-, and Amido-Camphor.—R. Schiff.—Not capable of useful abstraction.

Position of Bromine in Brom-camphor.—R. Schiff.—A brief hypothetical note.

Action of Zinc Chloride upon Brom-camphor.—R. Schiff.—By heating these bodies together to 150° to 160° the author obtained a hydrocarbon and a phenol, which are here described.

Nitro-derivatives of Mono- and Disulpho-diphenylic Acid.—S. Gabriel and A. K. Dambergis.—Not susceptible of abstraction.

On Camphoro-carbonic Acid.—J. Kachler and F. V. Spitzer.—This compound undergoes spontaneous decomposition below 100°. It can be crystallised from water, the temperature of which must not exceed 80°, and forms long colourless needles, which melt at 123° to 124°. If treated with metallic sodium in a solution of absolute ether, there is formed a brilliantly white, non-hygroscopic, sodium compound.

Production of Lauric, Myristic, Palmitic, and Stearic Aldehyds.—E. Kraft.—This memoir does not admit of useful abridgment.

On Amarine.—A. Claus and K. Elbs.—The authors have obtained and studied amarin-methyl-iodide, amarin-benzyl-chloride, methyl-amarine, and benzyl-amarine.

A New Synthesis of Sulphydantoine.—R. Andreasch.—The author has obtained this compound by the mutual action of cyanamide and thio-glycolic acid. In this manner sulphydantoines in general may be obtained from the thio-acids.

On Carbamid-sulphon-acetic Acid.—By R. Andreasch.—This compound is a derivative of sulphydantoine, obtained by treating the latter in crystals with hydrochloric acid and finely powdered potassium chlorate.

On Chlorinised Quinones.—S. Levy and G. Schultz.—The authors have found it possible to proceed from monochloro-quinon in a regular series to chloranil.

Atomic Weight of Ytterbium, and on certain of its Salts.—L. F. Nilson.—The author gives 173.01 as the atomic weight of ytterbium. Ytterbia is decidedly a sesquioxide, Yb₂O₃.

Atomic Weight and certain Characteristic Compounds of Scandium.—L. F. Nilson.—The atomic weight of this element is 44.03. Its earth, scandia, is

without doubt Sc_2O_3 . It is especially interesting that the atomic weight deduced from the author's determinations for scandium exactly the same figure as Mendeleeff has assigned to the predicted element "ekabor," which is doubtless identical with scandium. The molecular heat and volume of scandia characterise this earth as an intermediate member between glucina and yttria.

Atomic Weight and Essential Properties of Glucina.—L. F. Nilson and Otto Pettersson.—Assuming glucina to be a sesquioxide, the atomic weight of glucinum is 13.65. Glucina claims a place among the earths, R_2O_3 , on account of its molecular heat and molecular volume. The authors, in conclusion, reply to the criticisms of Mr. T. Carnelley, who makes glucinum a bivalent element.

Molecular Heats and Volumes of the Rare Earths and their Sulphates.—L. F. Nilson and O. Pettersson.—The authors give in a table the formulae, molecular weights, specific weights, specific heats, molecular heats, and molecular volumes of glucins, aluminas, scandia, gallium oxide, yttria, indium oxide, erbia, ytterbia, lanthanum oxide, didymium oxide, zirconia, cerium oxide, and thorium. The chromic oxide, ferric oxide, yttria, didymium oxide, erbia, ytterbia, and cerium oxide are magnetic, whilst glucina, alumina, scandia, indium and lanthanum oxide, zirconia, and thorium are diamagnetic.

Chemical Composition of certain Hydrated Oxides.—J. M. van Bemmelen.—The author gives a tabular view of the molecules of water associated with 1 molecule of water in silica, metastannic acid, stannic acid, hydrous manganese dioxide, and black manganese dioxide. He concludes that the water of hydration is in general a variable accidental magnitude, depending on certain temperatures, degrees of atmospheric moisture, and modifications of the oxide.

Non-existence of Potassium Copper Chromate, and on Two New Basic Copper Chromates.—Max Rosenfeld.—The two basic chromates are respectively yellow, $2\text{CrO}_3 \cdot 7\text{CuO} + 5\text{H}_2\text{O}$; and brown, $\text{CrO}_3 \cdot 7\text{CuO} + 5\text{H}_2\text{O}$.

Lecture Experiments.—M. Rosenfeld.—An illustrated paper.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 1, 1882.

A Curious Chemical Anomaly.—Already inserted at length.

Biedermann's Central-Blatt für Agrrikultur-Chemie,
Vol. x., Part 12.

The Results of the Principal Experiments of Lawes and Gilbert.—Dr. Paul Behrend.—An abstract from the publications of the Royal Agricultural Society.

Behaviour of Different Phosphates in the Soil.—Dr. Hoffmeister.—The result of the experiments is that by far the greater part of the phosphoric acid originally soluble in ammonium citrate remained in this, or in a very similar state at the end of the experiments. The fear that a part of the soluble phosphoric acid of the superphosphate might quickly be converted into the insoluble tribasic state proved unfounded.

Prof. Heeren's New Milk-Test.—This newly-invented instrument, the "piscopie," consists of a disc of black vulcanised caoutchouc, having in its middle a very flat, circular depression. A few drops of the milk in question, well mixed, are placed in the hollow and covered with the second part of the apparatus,—a plate of glass painted with six shades of colour radiating out from a small uncoloured circular spot in the middle. The colours range from white, grey, to deep bluish grey. The layer of milk is seen through the uncoloured spot in the centre, and its colour can thus be compared with the radiating colours, and its quality is judged according to the colour with which it coincides. Thus the whitest colour stands for cream, the next for very rich milk; then follow in succession—normal, inferior, poor, and very poor.

MEETINGS FOR THE WEEK.

- MONDAY, 27th.—Geographical, 8.30.
— Medical, 8.30.
— Society of Arts, 8. "Hydraulic Machinery," by Prof. John Perry.
TUESDAY, 28th.—Institute of Civil Engineers, 8.
— Royal Medical and Surgical, 8.30.
— Royal Institution, 8. "The Mechanism of the Series," by Prof. J. G. M'Leod.
WEDNESDAY, 29th.—Society of Arts, 8. "A New Antiseptic Compound, and its Application to the Preservation of Food," by Prof. Baril, M.A.
THURSDAY, 30th.—Royal, 4.30.
— Royal Institution, 3. "Resemblances of Sound, Light, and Heat," by Professor Tyndall.
— Chemical, 8. (Academy).
FRIDAY, 31st.—Royal Institution, 8. "Electric Discharge in a Magnetic Field, by Mr. W. Spottiswoode, at 9.
SATURDAY, April 1st.—Royal Institution, 3. "Volcanoes," by Prof. H. G. Seeley.

ERRATA.—In Dr. Debus's Lecture on "The Chemical Theory of Gunpowder" (p. 91, Col. 1, line 25 from top, for "ammonia acid hydrogen," read "ammonia, hydrogen, and water." Line 15 from bottom, for "of the volume," read "by the volume." P. 93, col. 1, line 34 from top, for "the sulphides," read "the higher sulphides." In same paragraph, for "quantity of potassic sulphide," read "quantities of potassic sulphate." P. 93, col. 1, line 6 from bottom, for "aCO₂" read "aCO."

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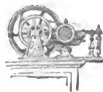
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THE CHEMICAL NEWS.

Vol. XLV. No. 1166.

ON THE SULPHATES OF ALUMINIUM.

By SPENCER UMFREVILLE PICKERING, B.A. Oxon.,
Assistant Master at Highgate School, and Chemical Lecturer
at Bedford College.

(Continued from p. 125.)

V. Solution of Aluminium Hydrate and Basic Sulphate by the Normal Sulphate.

SOME of the normal sulphate was treated with excess of ammonia, and the precipitate, after being washed, was dissolved in hydrochloric acid, and re-precipitated in the same way; after it had been well washed it was found to contain no trace of sulphate or chloride. Small quantities of the moist hydrate thus obtained were gradually added to boiling solutions of the normal sulphate of various strengths until a further addition caused a cloudiness which would not disappear, even when the ebullition was continued for one to four hours longer. The strength of the normal solution taken varied between that of one which was nearly saturated at the boiling temperature, and which entirely solidified on cooling, and a 1 per cent solution. The water expelled during the ebullition was replaced. All the basic solutions thus obtained remained quite clear on standing for an indefinite time in the cold; their composition is given in the third column of Table II., and the numbers here show that the amount of alumina thus dissolved does not render the solution much more basic than a solution of the normal sulphate is (the normal sulphate containing 29.848 per cent of Al_2O_3), and that the basicity of the solution obtained increases regularly with the strength of the solution taken. The time required for the saturation of the normal sulphate varied from two hours in the case of Expt. 44 to about twenty-six hours in that of Expt. 47. All these solutions on dilution with cold water became more or less cloudy. In order to make sure that none of the sulphuric acid was driven off during the ebullition, Expt. 45 was repeated without the addition of any alumina; after being boiled for two and a half hours the sulphate was found to contain 29.918 per cent of Al_2O_3 , showing that none of the acid had been lost. Strongly ignited alumina was found to dissolve to a considerable extent in a strong boiling solution of the normal sulphate; it did not, however, dissolve so easily as the hydrated substance did, but no determination of the amount taken into solution was made.

On treating cold solutions of the normal sulphate with the moist hydrate, this latter was found to dissolve more or less quickly as the solution taken was stronger or weaker; but even in the case of the strongest solution (containing 16 per cent $Al_2O_3 \cdot 3SO_3$), the action is extremely slow, not being complete at the end of two months.

In order to see whether a basic sulphate would dissolve in the normal sulphate to a larger extent than the hydrate does, a sulphate containing about 68 per cent of alumina (obtained by the dilution of a strong basic solution) was taken and added gradually to a boiling 16 per cent solu-

tion of the normal salt. After the liquid had become saturated, it was found to contain a sulphate with 52.984 per cent of alumina, and was therefore considerably more basic than any solution obtained by the use of the hydrate. This percentage, however, corresponds to that of no definite compound, and it was proved that in this case also the basicity of the solution depended on its concentration, for even a very small addition of water to it while boiling caused a precipitate to separate, and the amount of this precipitate was increased by further dilution. The solution obtained in this experiment was very strong, being nearly saturated at the boiling temperature, and containing 0.5 grm. of the basic sulphate per c.c. Although it did not solidify at once on cooling, on standing, however, for a few days it did so without becoming cloudy, and it was apparently incapable of taking up any more of the basic sulphate on digestion with it in the cold. It could be diluted with a very small amount of cold water without decomposition (at least, without immediate decomposition), but a further dilution produced an abundant flocculent precipitate.

Here, again, in these experiments it is evident that the composition of the product varies with the physical conditions under which it is obtained, and affords no evidence whatever of the existence of any definite basic compound; nor do these experiments support Maus's statement (*loc. sup. cit.*), that by saturating a solution of the normal sulphate with aluminium hydrate or basic sulphate, a solution of $Al_2O_3 \cdot 2SO_3$ (containing 38.954 per cent of Al_2O_3) is obtained. Marguerite's statement on the subject will be discussed in the next paragraph.

VI. Ignition of Ammonium Alum.

When ammonium alum is heated, it first loses its water and then its ammonium sulphate, leaving a residue of anhydrous aluminium sulphate, which is very difficultly soluble in cold water, but easily soluble in boiling water. When this anhydrous aluminium sulphate is further ignited, it gradually loses its acid, and finally leaves a residue of pure alumina; this action, however, can only be completed by operating on very small quantities, and using a high temperature. On igniting a weighed portion of the alum in this manner for many hours and weighing it at intervals, the loss of acid was found to proceed constantly, but at a decreasing rate. After the ignition had been continued for some time, the product was still found to dissolve completely in boiling water, and this was found to be the case until it contained about 33 per cent of alumina; after this point, however, an insoluble portion made its appearance, and continued to increase in amount as the ignition was prolonged; in fact the whole action appears to be nothing but a continuous decomposition of aluminium sulphate into a more and more basic substance, and finally into alumina, this basic product dissolving entirely in the boiling solution of the still unattacked normal sulphate, so long as the amount of it present is not too great.

The above experiments were performed as a repetition of some work of Marguerite's (*Comptes Rendus*, xc., 1354), which consisted of partially decomposing the aluminium sulphate obtained by the ignition of ammonium alum, and dissolving the product in boiling water, a solution being thus obtained from which, on evaporation, rhombohedra, either simple or terminated in four-sided pyramids, crystallised out before the normal salt did, and which consisted of $Al_2O_3 \cdot 2SO_3$. Similar crystals, he states, were obtained in small quantities by dissolving aluminium hydrate in the normal sulphate; also by treating the normal sulphate with zinc. They dissolved easily in cold or hot water; to the extent of 45 per cent in the former. The only analytical numbers quoted are the following:—

| | | |
|-----------|---------|----------------|
| Al_2O_3 | $2SO_3$ | $12H_2O$ |
| 21.2 | 33.84 | 44.9 per cent. |

In some preliminary repetitions of these experiments, the author of the present paper obtained in each case

TABLE II.
Aluminium Sulphate Solution boiled with Aluminium Hydrate.

| | Strength of Normal Solution taken. | Composition of the Basic Sulphate in the Solution obtained. |
|-----|------------------------------------|---|
| 44. | 40 to 50 per cent | 34.83 per cent Al_2O_3 |
| 45. | 17 " | 34.647 " " |
| 46. | 2 " | 34.316 " " |
| 47. | 1 " | 33.532 " " |

small crops of crystals, which, though scarcely rhombohedral, might possibly at first sight have been mistaken for rhombohedra terminated in four sided pyramids. They also contained nearly exactly the same percentage of sulphur trioxide as those obtained by Marguerite. The alumina percentage, however, was very different, and it was soon discovered that these crystals were in reality nothing but potassium alum, which was found to be present as an impurity in every specimen of ammonium alum and of aluminium sulphate which could be procured in commerce; and although it is difficult to see how any chemists could have made such a mistake, still it is a remarkable fact that if the potassium oxide be calculated as alumina, the analytical numbers yielded by alum would be almost identical with those quoted by Marguerite. Thus in alum—

| | | |
|--|----------------|------------------------|
| $\text{Al}_2\text{O}_3 + \text{K}_2\text{O}$ | 4SO_3 | $24\text{H}_2\text{O}$ |
| 20.789 | 33.716 | 45.495 per cent. |

At any rate it may be stated that no confirmation whatever could be obtained of the existence of Marguerite's "new" sulphate, $\text{Al}_2\text{O}_3 \cdot 2\text{SO}_3$, which, however, had been described by Maus fifty-two years previously as an insoluble powder (*vide supra*), and that no crystals of any kind except those of the normal sulphate ever separated out on the evaporation of a basic solution, however obtained.

VII. Aluminium Sulphate Treated with Zinc.

Debray (*Bull. Soc. Chim.* (II.), vii., 9), by boiling some aluminium sulphate with zinc in a platinum capsule, obtained a precipitate which on analysis was found to contain 68.843 per cent of alumina (neglecting the water present), and which he therefore concluded to consist of $5\text{Al}_2\text{O}_3 \cdot 3\text{SO}_3$ (which requires 68.023 per cent Al_2O_3).

In order to make a more exhaustive examination of this action, solutions of the normal sulphate of various strengths were heated with distilled zinc in a steam-bath at 100°C ., condensing tubes being fitted into the flasks containing the solutions. With strong solutions hydrogen was given off at first with great energy, and after from two-and-a-half to forty hours the action became very slow indeed, and a cloudiness appeared in the solution: this cloudiness gradually increased till it formed a precipitate sufficient for analysis. The composition of the precipitate thus obtained in various cases is given in the first part of Table III. The figures in the second and third columns show that the deposition of the basic sulphate takes place more quickly as the solution is more concentrated: the numbers in the third column are, however, only approximations. The figures in the last column show that the precipitate formed is more basic as the solution taken is weaker.

TABLE III.

Aluminium Sulphate Solution Digested in Zinc at 100°C .

| No. | Strength of the Solution. | Duration of Heating. | Percentage of Al_2O_3 precipitated, that is in the solution taken being 100. | | Percentage of Al_2O_3 in the Anhydrous ppt. |
|-----|---------------------------|--------------------------------|--|------|---|
| | | | Per cent. | | |
| 48. | 3.6 | 15 hours | | 8.0 | 63.05 |
| 49. | 7.2 | 28 " | | 14.0 | 68.36 |
| 50. | 3.6 | 26 " | | 5.3 | 68.881 |
| 51. | 1.71 | 92 " | | 8.0 | 69.50 |
| 49. | 7.2 | 28 " | | 14.0 | 68.36 |
| 52. | 7.2 | From the 28th to the 41st hr. | | 8.7 | 68.9 |
| 53. | 7.2 | From the 99th to the 139th hr. | | 5.8 | 70.058 |
| 50. | 3.6 | 26 hours | | 5.3 | 68.881 |
| 54. | 3.6 | From the 26th to the 62nd hr. | | 9.0 | 69.043 |
| 51. | 1.71 | 92 hours | | 8.0 | 69.50 |
| 55. | 1.71 | From the 92nd to the 147th hr. | | 8.6 | 69.733 |

The last experiments given in the table were made in order to ascertain whether the precipitate deposited by any particular solution remained constant in composition during its deposition or not. Solutions of three different strengths were examined, and they all showed that without exception the precipitate became more basic as the action proceeded. The rate of its formation also gradually diminishes, as might have been expected, although to show this we must in the case of the first portion subtract from the numbers given in column 2 the time during which the zinc was dissolving and no basic sulphate was being deposited.

Here we see that although the precipitate obtained in this action is in most instances not very dissimilar from that obtained by Debray, still its composition is not constant, but varies with a variation in the physical conditions of the experiment. In fact no definite chemical compound can be regarded as being formed in this action.

In the above experiments a deposit was invariably formed on the glass vessel employed similar to the main precipitate, except that it dissolved only with great difficulty even in strong boiling hydrochloric acid (this being the only basic sulphate met with which was not easily soluble in the weak cold acid). It was not included in the portions taken for analysis as given in Table III., but a separate examination of that deposited in experiments 49 and 53 gave the percentages of alumina as being 56.971 in the first case and 60.905 in the other, showing that this less soluble deposit was not so basic as the main precipitates, and that like this latter it increased in basicity as the action proceeded.

When a platinum vessel was substituted for the glass flask used in the above experiments, the action appeared to be the same in kind, but proceeded with greater rapidity owing to the voltaic action of the two metals in contact with each other.

Debray (*loc. sup. cit.*), on leaving a solution of aluminium sulphate with zinc in a platinum dish at ordinary temperatures for eight days, obtained a jelly, which, when washed and dried over sulphuric acid, was found to contain 63.55 per cent of alumina (without including 49 per cent of water present).

On making a few experiments similar to that of Debray's, it was found that with saturated solutions, and solutions containing more than 18 per cent of the normal sulphate, the action which took place at first was soon stopped, owing in all probability to the insolubility of the zinc sulphate formed in the strong solutions; but that with a 17 per cent solution the whole became converted into a firm transparent jelly at the end of four or five days. On attempting to wash the jelly with solutions of the normal sulphate of decreasing densities it was found to dissolve easily and completely, while treatment with pure water made it opaque and entirely decomposed it, thus rendering it impossible to determine its composition. Debray's analysis must therefore refer not to this jelly, but to its decomposition product with water, more or less contaminated perhaps with some of the undecomposed jelly itself. On repeating these experiments with more dilute solutions, it was found that the jelly became more and more thin and cloudy, until with a 3.3 per cent solution no jelly at all was formed, and the sole product of the action was a white flocculent precipitate. The analysis of this precipitate, together with those of other precipitates, obtained in similar experiments with still more dilute solutions, is given in Table IV. The first four experiments in this table, with one exception, indicate a slight increase in the basicity of the precipitate, as the solution taken is stronger. The increase, however, is not greater than what might be put down to experimental error. The last three experiments were performed when the temperature of the laboratory was some degrees higher than in the other cases, and the precipitates here are less basic than the others, the first two of these showing a variation in the same direction as Nos. 56 to 58.

TABLE IV.

Aluminium Sulphate Digested with Zinc in the Cold.

| Strength of the Solution. | Al ₂ O ₃ precipitated, that in the sol. taken being 100. | Al ₂ O ₃ in the Anhydrous ppt. |
|---------------------------|--|--|
| 56. 1.10 per cent | 37.4 | 66.149 |
| 57. 1.64 " | 31.9 | 66.169 |
| 58. 1.95 " | 42.2 | 66.339 |
| 59. 3.3 " | 33.6 | 66.215 |
| 60. 0.66 " | 33.4 | 65.181 |
| 61. 0.78 " | 48.2 | 65.979 |
| 62. 2.47 " | 32.0 | 64.625 |

The close concordance of the first four numbers would suggest that the precipitate might be a definite chemical compound were it not that these numbers do not correspond to any particular formula, the one which they most nearly satisfy being $3\text{Al}_2\text{O}_3 \cdot 2\text{SO}_3$, which requires 65.687 per cent of alumina. It might even here be possible that they did consist of this basic sulphate, since their being rather more basic than the formula requires might be due to the decomposing action of the wash-water, but that in the cases of Nos. 60 and 62 we have some which are less basic than $3\text{Al}_2\text{O}_3 \cdot 2\text{SO}_3$, even in spite of this decomposing action. In addition to this we have the fact that the composition of the product evidently depends to a considerable extent on the temperature at which the action takes place. On the whole, it would seem to be extremely rash to assume that these precipitates are constant in composition, or that they consist of a definite chemical compound.

(To be continued.)

THE "VIDANGEUSE AUTOMATIQUE."

THIS apparatus is described as a closet hermetically closed, completely inodorous, and emptying itself incessantly. The Abbé Moigno in describing the sewage difficulty declares that, prior to this new invention, due to M. Louis Mouras, not a single effective step had been taken towards the solution of the problem. He declares that the Vidangeuse is hermetically closed by the safest of closings, the hydraulic joint, so that its contents are cut off from all contact with the ambient air, whence it is inodorous and all infection is rendered impossible. Further, by a "mysterious operation, which reveals a principle entirely novel," the apparatus transforms all that it receives, liquid and solid excreta, in a very short time and "without any addition of chemical ingredients" into a homogeneous liquid, scarcely turbid, which holds everything in suspension in the state of filaments scarcely visible, without depositing anything, either on the sides of the soil-pipe or at the bottom of the sewer. It empties itself automatically and incessantly; that is, each new volume of excreta introduced by the fall-pipe causes the discharge of an equal volume of the former contents elaborated and fluidified. The liquid as it issues out, deprived of none of the organic or inorganic elements of the excreta, may be received at once in a butt to serve for watering the garden, or it may flow into the sewer. The describer states that any existing closet can be arranged in accordance with the new system by merely adding a fall-pipe dipping with its lower end into the liquid in the "vidangeuse" and a discharge pipe which plunges with its bent upper end into the same liquid whilst the lower end is connected with the sewer.—*Les Mondes*.

(As the "vidangeuse" is protected by a patent a more complete description will doubtless follow).

Essence of Licari Kanali.—H. Morin.—The author has isolated from this product a hydrocarbon, $\text{C}_{20}\text{H}_{36}$, to which he gives the name licarene.—*Comptes Rendus*.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, March 25th, 1882.

Prof. CLIFTON, President, in the Chair.

New members.—Mr. M. J. Jackson, B.A.; Mr. Nazarus Fletcher, British Museum.

Mr. SHELLFORD BIDWELL read a paper on the "*Electric Resistance of a Mixture of Sulphur and Carbon*." These experiments were begun in December, 1880, to ascertain if the mixture in question was sensitive to light like selenium. Sulphur was melted and mixed with powdered plumbago, the best proportions being 20 parts by weight of the sulphur to 9 parts of the plumbago. The mixture was poured into moulds and quickly cooled, yielding plates and sticks. When exposed to the light of a gas flame, an increase in resistance was noticed, and was proved to be due to the heat of the flame, not the light, by experimenting with different sources of light and coloured screens of glass. As both carbon and sulphur decrease in resistance under heating, this opposite effect of the mixture is anomalous, and Mr. Bidwell explains it by supposing that the mixture is mechanical, and that heat expanding the size of the insulating sulphur crystals separates the conducting carbon particles further apart, and increases the resistance of the mass. Cells of this compound were made like selenium cells by spreading it between the parallel turns of two fine platinum wires wound round a mica plate, and the rise of resistance for temperature carefully measured. At 14° C. the resistance was 9100 ohms, at 55° C. it was 5700 ohms, and the rise was in greater ratio than the rise of temperature. Mr. Bidwell also found that these cells would transmit speech when connected in the circuit of a battery and a Bell telephone; they also acted as a thermoscope, when employed after the manner of a thermopile. Mixtures of shellac and graphite, of paraffin and graphite, &c., were also tried with like results.

In reply to Prof. Macleod, Mr. BIDWELL said the resistance of the cells decreased soon after being made. Mr. Bidwell also stated that acting on a suggestion of Dr. Hopkinson, he had found that the resistance diminished under a more powerful current. This material would not answer for resistance boxes.

Mr. C. V. BOYS read a paper on a "*New Method of finding the Index of Refraction of Lenses*," based on the general principle employed by Foucault of causing the ray of light to return on the same path.

Prof. CLIFTON stated that a similar method was now employed by him at Oxford, and was useful for small lenses.

Prof. FITZGERALD, of Dublin, showed mathematically that it was impossible for a small charge of static electricity carried along by the earth to move a magnet in its neighbourhood.

Prof. AYRTON questioned this conclusion, and exhibited an apparatus intended to test the point experimentally.

The meeting was then adjourned till April 22.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, February 23, 1882.

Mr. B. S. PROCTOR in the Chair.

THE minutes of last meeting were read and confirmed.

Messrs. J. R. Young, A. J. Smith, C. E. Stuart, B.Sc., and Dr. Rudolph Messel, were elected members of the Society.

The following papers were read:—

"On the Estimation of Arsenic in Copper," by JOHN PATTINSON, F.I.C., F.C.S. However delicate as a qualitative test for the presence of small quantities of arsenic in copper Messrs. Abel and Field's method, described in the *Quarterly Journal of the Chemical Society* for 1862, may be, I have found that it gives very uncertain and untrustworthy results when used as a quantitative method for the determination of this substance. Messrs. Abel and Field's method consists in adding a small quantity of nitrate of lead to the nitric acid solution of about 200 grains of the copper to be tested, and then excess of ammonia and carbonate of ammonia. The lead precipitate thus formed, which is supposed to contain all the arsenic contained in the copper, is then separated by filtration and washed, and the arsenic it contains dissolved by digesting the precipitate with solution of oxalic acid, ultimately obtaining the arsenic as ammonio-magnesium arsenate, with or without previous precipitation as sulphide. When carefully following all the instructions given in the above named paper, this method, when applied to a solution of copper known to contain 0.05 per cent of arsenic, only indicated 0.006 per cent of arsenic.

In attempting to discover a method which would give better results than this method, I have found that if a solution of copper in nitric acid is carefully neutralised with solution of caustic soda, and then a slight excess of the soda solution added, all the arsenic the copper contains is entirely precipitated as arsenate of copper before hydrated cupric oxide is precipitated; and, moreover, that hydrated cupric oxide precipitates arsenate of copper from solutions of copper so neutralised. On this reaction is based the process of estimating small quantities of arsenic in commercial copper which I have to describe.

From 100 to 400 grains of the copper to be examined, the amount varying with the quantity of arsenic supposed to be present, are dissolved in nitric acid. Solution of caustic soda is then carefully added to the cold or slightly warm solution until a slight but permanent finely divided precipitate is formed. A quantity of very dilute caustic soda, containing soda equal to twice the weight of arsenic supposed to be present, is now added, and the mixture well stirred every five minutes during half an hour to ensure the precipitation of the whole of the arsenate of copper. Care must be taken to use very dilute solution of soda when the free acid is nearly neutralised, and for the final precipitation, otherwise undesirable clots of hydrated cupric oxide will be formed. The precipitate is then collected on a filter and washed once or twice with cold water. The filtration is hastened if the solution with its precipitate is boiled after the soda has been added, but in this case it must be again cooled and allowed to stand for about an hour before being filtered, as the precipitate appears to be slightly soluble in a heated solution.

When examining unknown qualities of copper containing much arsenic, should any doubt exist that an insufficient amount of soda has been added to precipitate the whole of the arsenic, a second amount of soda should be added to the filtrate after the first precipitate has been separated, and the precipitate thus formed collected on a filter, dissolved in a little hydrochloric acid, and ammonia and magnesia mixture added and well stirred. The formation of a precipitate of ammonio-magnesium arsenate indicates the presence of arsenic. This precipitate should be collected and weighed. If no ammonio-magnesium arsenate precipitate is formed, the whole of the arsenic is in the precipitate formed by the first addition of soda.

Ammonia and its salts must not be added to the solution of copper from which the arsenic is to be thus separated, as I find they interfere with the complete precipitation of the arsenic.

The after-treatment of the precipitate formed by the addition of soda, and which contains the whole of the arsenic, depends on the presence or absence of other impurities in the copper.

I.—If, on dissolving the precipitate in hydrochloric acid and adding excess of ammonia, it is found that no insoluble matter remains in the solution, the arsenic acid may be at once precipitated as ammonio-magnesium arsenate by the addition of magnesia mixture (chloride of magnesium, chloride of ammonium, and ammonia). In the absence of phosphorus the ammonio-magnesium precipitate indicates arsenic only, but if phosphorus be present, the latter precipitate, after being weighed, should be dissolved in hydrochloric acid, and arsenic precipitated as tersulphide by sulphuretted hydrogen. The phosphoric acid in the filtrate is then again precipitated as ammonio-magnesium phosphate, the precipitate weighed and deducted from the weight of the first ammonio-magnesium precipitate.

Should phosphorus be present in the copper, the arsenic may also be separated from it by precipitating the arsenic as tersulphide before the formation of the ammonio-magnesium precipitate as described further on.

A sample of copper known to contain no arsenic or phosphorus, but to the solution of which arsenic acid equal to 0.5 grain of arsenic had been added, was tested by what may be termed the direct method described above, and an amount of ammonio-magnesium arsenate was obtained representing 0.5 grain of arsenic.

II.—Should the addition of ammonia to the solution in hydrochloric acid of the precipitate formed by the addition of soda to the copper solution give a precipitate, then the solution, if warm, should be cooled, and sulphide of ammonium added in excess, and the mixture allowed to stand for a few minutes in the cold. The insoluble sulphides are then separated by filtration and the arsenic acid is precipitated in the filtrate by magnesia mixture. Care must be taken that the solution is not washed after the addition of sulphide of ammonium, otherwise the arsenic acid would be more or less reduced, and no precipitate of ammonio-magnesium arsenate may be formed.

Here, again, should phosphorus have been present in the copper it will also be obtained in the ammonio-magnesium precipitate and should be afterwards separated as before-described.

The results obtained by treating copper containing mixtures of various impurities and with known quantities of arsenic by this method were very satisfactory. A mixture of 200 grains of pure copper and 0.25 grain each of antimony, lead, bismuth, tin, and iron, to which 1.0 grain of arsenic was also added, yielded ammonio-magnesium arsenate equal to 0.98 grain of arsenic. Other analyses with various quantities of arsenic gave equally good results, and occasionally exactly the same amount of arsenic was found as was added to the mixture of metals.

When the copper to be tested contains iron and other impurities in some quantity, and when it is uncertain whether or not phosphorus is also present, the best way to proceed to separate the arsenic from the other substances carried down with the precipitate formed by the addition of caustic soda is probably as follows:—The last-named precipitate is dissolved in a little hydrochloric acid (any portion insoluble in this menstruum being allowed to remain in suspension in the liquid), ammonia and sulphide of ammonium in excess added, and the mixture kept at a temperature a little below boiling for about an hour. The precipitate of sulphides is then separated by filtration and the filtrate is acidified with hydrochloric acid. The arsenic, which has been reduced from arsenic acid to arsenious acid by the digestion with hot sulphide of ammonium, is readily precipitated as tersulphide, together with any antimony or tin the solution may have contained. These sulphides are then collected on a filter and washed and afterwards dissolved in fuming nitric acid. The arsenic acid is then precipitated by magnesia mixture after addition of excess of ammonia, and obtained as

ammonio-magnesium arsenate from which the percentage of Arsenic is calculated.

Analyses made by the method last described have given very good results. Amongst several analyses made by this method may be mentioned the following:—Two mixtures of 100 grains of copper and 0.25 grain each of antimony, lead, bismuth, tin, and iron, to which 0.5 grain and 0.1 grain of arsenic respectively had been added, yielded 0.48 grain and 0.50 grain of arsenic respectively.

My thanks are due to my assistant, Mr. H. A. Kay, who has made most of the required analyses, and who has otherwise given much valuable help in carrying out this investigation.

"Contributions to the History of the Oxides of Manganese." By J. T. DUNN, M.Sc. Wishing to determine sulphurous acid dissolved in oil of vitriol, and casting about for a method which would not involve the use of such large bulks of air-free water as are necessary for accuracy in titrating with iodine, I tried, amongst other things, solution of permanganate of potassium. I proposed to sink the measured quantity of SO_2 solution under excess of standard permanganate solution, and to determine the amount of oxygen used up by excess of standard ferrous sulphate solution and back titration with permanganate. Of course, on adding the SO_2 to excess of permanganate, a quantity of brown hydrated oxide of manganese is precipitated, but addition of acidified ferrous sulphate, as is well known, easily reduces and dissolves this oxide.

It had long been well known that the precipitates produced by the action of reducing agents on excess of permanganate, as well as those formed by acting with alkalis and oxidising agents on manganous salts, have not, as a rule, the composition of manganese dioxide, but contain a percentage of oxygen falling short more or less of that required for the formula MnO_2 . Mr. Francis Jones states (*Four. Chem. Soc.*, 1878, page 95) that he has observed an evolution of oxygen gas in all cases of the action of reducing agents on permanganate which he has examined, although he gives us no figures, nor any guide whatever as to the amount of gas which he has noticed. So far as I am aware, no other author who has experimented with oxides of manganese makes any mention of oxygen being given off under these circumstances; but a possible connection between the evolution of oxygen and the deficiency in oxygen below the formula MnO_2 exhibited by the precipitated oxides, at once suggests itself.

In my work with sulphurous acid, since it was necessary, in order to insure the complete diffusion of the saturated acid out of the narrow-necked little bottle in which it was weighed, to permit the permanganate solution under which it was sunk to stand over night, it is evident that any such evolution of oxygen as that mentioned by Jones, even if it took place very slowly, would have rendered the determinations useless. I endeavoured, therefore, to repeat some of Mr. Jones's experiments under determinate conditions, to ascertain whether, under these conditions, evolution of oxygen did take place, and, if so, to what extent. I afterwards, for other reasons, abandoned the use of permanganate in favour of bichromate; but the results of the few experiments which I made are perhaps worth while putting on record.

A small flask was taken, fitted with a two-holed cork, through which passed a gas-delivery tube and the tube of a stoppered funnel, the latter reaching to the bottom of the flask. Flask and delivery tube were completely filled with a solution of about 15 grms. of manganous sulphate (the same sulphate was used in all the experiments, and contained 11.32 per cent of water), and a solution of 0.63 gm. of permanganate, in a small quantity of water, was added through the funnel tube without admitting any air, the delivery tube of the flask dipping under water, and having a graduated tube filled with water inverted over it.

Immediately on the introduction of the permanganate a brown flocculent precipitate formed, but, after half an hour, there was no evolution of gas. The fluid in the

flask was now boiled, and yielded, after three-quarters of an hour, about 5 c.c. of gas, the precipitate at the same time becoming quite black. This gas was certainly not pure oxygen, and as an equal bulk of the distilled water used in making the solutions yielded, on boiling for the same length of time, about the same quantity of gas, there seems no reasonable doubt that in both cases the gas was air dissolved in the water, or which had diffused into the apparatus.

The experiment was next repeated, the flask this time being filled with a solution of about 5 grms. of permanganate, and 1.02 grms. of the manganous sulphate was dissolved in water, and run into it. The same brown precipitate was observed, but again no gas was given off in the cold. On boiling a slow evolution of gas took place, which ceased after about an hour, during which time about 200 c.c. was collected. A lighted match showed that the gas contained a large quantity of oxygen, and absorption of a sample by phosphorus showed that it was practically pure.

A blank experiment, made for precaution's sake, in which the same quantity of permanganate solution was boiled for an hour, without addition of manganous sulphate, and in which only 7 c.c. of gas was given off, showed that the gas in the last experiment did not come from the simple breaking up of the permanganate by heat.

The experiment was repeated with the same quantities of the materials, and they were left together in the cold for five days. No gas was collected in the measuring tube, but a few minute bubbles appeared hanging on to the precipitate.

It seems, then, that when solutions of permanganate and manganous sulphate are mixed, no evolution (practically) of gas takes place in the cold, and that, on heating, oxygen is evolved when the permanganate is in excess, but not when the manganous salt is in large excess. I next tried to ascertain whether the action was a determinate one, or whether, as seemed possible, it was an example of so-called "catalytic" action—whether the precipitated oxide acted towards the excess of permanganate in the way that cobaltic hydrate does towards bleaching-powder in Fleitmann's method of preparing oxygen.

A small quantity of the moist precipitated hydrate from the last experiment, which had been washed in the cold till free from adhering permanganate, was placed in the flask, which was then filled with permanganate solution (about 5 grms. of the salt). The precipitate and the fluid were then boiled together, but, after two hours, only about 20 c.c. of gas had collected, which was found to be oxygen. Again, the flask was filled with the same quantity of permanganate, and a solution of 0.25 gm. of manganous sulphate added, and boiled; 46 c.c. of gas was collected, and shown to be oxygen; and it will be noticed that the quantity bears roughly the same ratio to the 200 c.c. collected in a former experiment that the manganous sulphate used here does to that used in the other case.

The reaction was then apparently definite, and it seemed worth while, if possible, to put it on a quantitative basis. Decinormal solutions of permanganate and of manganous sulphate were prepared, containing 3.16 grms. and 1.51 grms. of the salts respectively per litre. (The permanganate was rather above decinormal strength, 100 c.c. being equivalent to 100.4 c.c. decinormal solution.)

Into the flask was introduced 100 c.c. (=100.4) permanganate solution, and the air was then displaced by a stream of CO_2 ; 100 c.c. of MnSO_4 solution was added through the funnel tube without introducing air, and the liquid and precipitate boiled together for two hours, the gas given off being collected over caustic soda. After allowing for the small quantity of residual air in the flask, 23 c.c. of oxygen remained. The contents of the flask were poured on an asbestos filter, and the precipitate washed. The filtrate was perfectly colourless, and hence contained no permanganate. It gave no precipitate with

ammoniac sulphide, and thus contained no manganese; so that the whole of the manganese both of the permanganate and the manganous salt had gone into the precipitate. The precipitate was run into excess of potassic iodide solution, as suggested by Pickering (*Jour. Chem. Soc.*, 1879, page 654), and the available oxygen determined by titration with hypo.

The results are as follows:—

| | |
|---|--------|
| Total Mn in precipitate (calc. from salts used) | 0.1654 |
| Equivalent O calculated | 0.0482 |
| Available O found | 0.0475 |
| Total available O in KMnO_4 used | 0.0803 |
| O found, 0.0475 + 0.0329 (gas) | 0.0804 |

These figures agree very closely with the equation—



The precipitate contains manganese and oxygen in proportions which agree very closely with the formula MnO_2 . Potassium in the precipitate was not looked for, but it doubtless was present, as in all similarly formed oxides which have been examined. The very close agreement between the observed "total available oxygen" and that calculated from the KMnO_4 is to be attributed to accident, because the gas measurements throughout were of the very roughest, and I have not based any quantitative conclusions on them, but have relied entirely on the determination of the oxygen in the precipitate, being content to find that the gas measurement approached at all closely to the difference between that and the total available oxygen in the permanganate.

The experiment was now repeated, using 200.8 c.c. KMnO_4 and 100 c.c. MnSO_4 . Oxygen given off, 19 c.c. = 0.0262 gm. Filtered as before. The filtrate was made up to 500 c.c., and the KMnO_4 and total manganese determined in portions by ferrous sulphate and permanganate, and by reduction by SO_2 , precipitation as sulphide, and conversion into sulphate respectively. The filtrate contained KMnO_4 equivalent to 107.1 c.c. decinormal solution, whence 93.7 c.c. had gone into the precipitate. The manganese in the filtrate was 0.1150 gm., and that calculated from the KMnO_4 present 0.1178 gm., so that the whole of the manganese from the MnSO_4 was in the precipitate. The precipitate was treated as before:—

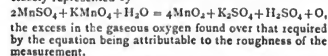
| | |
|--|--------|
| Total Mn calculated from 93.7 c.c. KMnO_4 and 100 c.c. MnSO_4 | 0.1581 |
| Equivalent O calculated | 0.0460 |
| Available O found | 0.0457 |
| Total available O in KMnO_4 | 0.0750 |
| Found 0.0457 + 0.0262 (gas) | 0.0719 |

Here again the precipitate is practically MnO_2 (with possible K_2O), and the same equation would represent the reaction, only that the amounts of KMnO_4 used up, and of oxygen given off, are somewhat below those required by the equation, a portion of the oxygen which before came off as gas appearing to have done the work of the 6.3 c.c. of KMnO_4 .

In the next experiment 200 c.c. MnSO_4 solution was used, and 100 (=100.4) c.c. KMnO_4 . The oxygen given off was 12.8 c.c. = 0.0170 gm. The filtrate was this time colourless, and contained no manganese. The precipitate showed 0.0638 gm. available O:—

| | |
|---|--------|
| Total Mn in precipitate (calc. from salts used) | 0.2208 |
| Equivalent O calculated | 0.0643 |
| Available O found | 0.0638 |
| Total available O in KMnO_4 | 0.0803 |
| Found 0.0638 + 0.0170 (gas) | 0.0808 |

Again the precipitate is MnO_2 , and the reaction is very closely represented by—



The same experiment was repeated with 150 c.c. MnSO_4

solution and 50.2 c.c. KMnO_4 . Oxygen given off, 2.1 c.c. = 0.0027 gm. Filtrate contained no manganese:—

| | |
|---|--------|
| Total Mn in precipitate (calc. from salts used) | 0.1377 |
| Equivalent O calculated | 0.0400 |
| Available O found | 0.0375 |
| Total available O in KMnO_4 | 0.0402 |
| Found 0.0375 + 0.0027 (gas) | 0.0402 |

This time the precipitate exhibits a distinct deficiency in oxygen, the figures calculating out to a mixture of 0.0111 gm. MnO with 0.2040 gm. MnO_2 , or a formula of approximately $\text{MnO}_{1.15}\text{MnO}_2$. The equation here would seem to be that on which Guayard based his volumetric process,—
 $3\text{MnSO}_4 + 2\text{KMnO}_4 + 2\text{H}_2\text{O} = 5\text{MnO}_2 + \text{K}_2\text{SO}_4 + 2\text{H}_2\text{SO}_4$,
 only that a small portion of the oxide has broken up, giving off part of its oxygen.

200 c.c. MnSO_4 solution and 50.2 c.c. KMnO_4 were now boiled together. Practically no gas was given off. Filtrate contained no KMnO_4 , but showed manganese equivalent to 0.0552 gm. MnSO_4 , whence 0.3120 gm. corresponding to 170 c.c. decinormal solution, had gone to form the precipitate:—

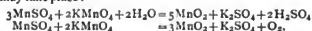
| | |
|---------------------------------|--------|
| Total Mn in precipitate | 0.1485 |
| Equivalent O calculated | 0.0432 |
| Available O found | 0.0396 |

So that in this case, again, the oxide is deficient in oxygen, the nearest formula being $\text{MnO}_{1.11}\text{MnO}_2$. Here, then, Guayard's equation probably holds in the first case, but the oxide formed takes up more manganese from the excess of sulphate present.

Two experiments were then tried in the cold, one with 100 c.c. of each of the solutions, the other with 150 c.c. MnSO_4 and 50 c.c. KMnO_4 . A few small gas bubbles detached themselves, and both precipitates exhibited small deficiencies in oxygen, but the results agreed approximately in both cases with Guayard's equation.

As a result of the whole, it seems that when permanganate and manganous sulphate react on each other in the cold the reaction is approximately expressed by Guayard's equation, and any excess of either salt over the proportion represented by $3\text{MnSO}_4 : 2\text{KMnO}_4$ remains unacted on; but that this statement is only approximate, that the precipitate always contains less oxygen than corresponds to the formula MnO_2 , and that this deficiency in oxygen is not attributable to the escape of oxygen gas, which appears, however, to take place to a very small extent when the permanganate is in excess, but to the fact that rather more MnSO_4 and rather less permanganate enter into the reaction than the equation represents.

When the solutions are boiled together two reactions may take place:—



If the salts are in the proportions required for the first reaction, this reaction takes place almost exactly; there is, however, a tendency for the precipitate to be low in oxygen, which is increased if the amount of MnSO_4 present exceeds that required by the equation. If the ratio which the quantity of KMnO_4 bears to that of MnSO_4 is between that required for the first equation and that required for the second, the whole of the manganese of both salts is precipitated, the precipitate has the composition MnO_2 , and the whole of the oxygen of the permanganate in excess of that required to form MnO_2 with the whole of the manganese is given off in the gaseous form. If more KMnO_4 is present than is required for the second equation, the excess remains practically unacted upon.

It is to be noted, however, that the solutions with which I have worked are very weak ones, and that Wright and Menke (*Journ. Chem. Soc.*, 1880, page 23) have shown that with the same proportions of KMnO_4 and MnSO_4 the strength of the solutions used influences the composition of the precipitate, which exhibits a greater deficiency of oxygen as the strength of the solutions in-

creases. The evolution of oxygen, however, when the permanganate is in excess of the quantity required for Guyard's equation, takes place both in strong and weak solutions. This decomposition of the permanganate, too, would seem to be the cause of the high results which, as they state, Wright and Menke obtained with their modification of Guyard's volumetric process when the permanganate solution was used hot; and in this connection it would seem desirable to examine a little more closely than I have been able to the action of the hydrate precipitated in the cold upon hot solutions of permanganate.

Professor HERSCHTEL exhibited, for Mr. J. B. Payne, a new cheap form of voltaic cell, invented by Mr. Alfred Bennett, of Glasgow. It consisted of an inner porous cell containing zinc in caustic soda solution, packed in iron filings contained in an outer cell which was made out of an Australian meat tin. Twelve of these cells in series kept a small Swan lamp glowing brightly, and it is claimed for the battery that it keeps up its electromotive force for a very long time.

NOTICES OF BOOKS.

Handbook of the Polariscopes and its Practical Applications. Adapted from the German Edition of H. LANDOLT, Professor of Chemistry at the Polytechnicum, Aachen, by D. C. ROBB, B.A., and V. H. VELEY, B.A., F.C.S., with an appendix by T. STEINER, F.C.S. London: Macmillan and Co.

THE appearance of this work in an English version appears to be due, in the first instance, to Mr. F. Faulkner, of St. Helens. At his request a translation was executed by Mr. H. M. Chichester, and the manuscript was placed in the hands of Mr. Robb for revision and editing. This gentleman, in his preface, takes upon himself the responsibility, though not all the credit of the work, but his death, about a year ago, not merely led to considerable delay, but necessitated a last revision by Mr. Veley. We are, therefore, brought in contact with five distinct minds, and cannot presume to determine what share of credit is due to each.

As to the need for a treatise of this nature there can be no question. Now that physical and especially optical properties are so largely used in identifying and characterising organic compounds, such a manual ought to be accepted as no trifling boon. Strange as it may sound, we have from time to time received communications from persons of some standing in the chemical world seeking the meaning of symbols in which the rotatory power of different bodies is expressed. The treatise before us is at once theoretical and practical; the authors explain the polarisation of light in its various phases, and especially the nature of rotatory power. They then proceed to the process of determining specific rotation, and ultimately to the application of the methods in quantitative analysis.

We find, as an introduction, an account of the difference between ordinary and polarised light, of polarisation by reflection, and of the simple polariscope. The reader is then made acquainted with the rotation of the plane of polarisation, or, as it is commonly called, circular polarisation.

In the second chapter we find a classification of optically active substances. There are those—either organic or inorganic—which possess the power of rotating the plane of polarisation only when solid and in a crystalline state. If dissolved or melted they become inactive. Again, there are bodies which possess rotatory power when dissolved, and if volatile, even in the gaseous state. These substances, if capable of crystallisation, become inactive when crystalline. There is yet a third class which possess rotatory power, both when crystallised and when dissolved. So far as is yet known all the substances

belonging to the last two classes are organic bodies,—either naturally occurring in plants and animals, or derived from them by simple metamorphoses. Thus we find here the sugars, the gums, many of the principal vegetable acids, a number of the essential oils and camphors, alkaloids, the gelatinous substances, and the soluble albumens and peptones. Hence it would seem that the power of circular polarisation in solutions as distinct from crystals is a property of the carbon atom. We do not know whether optical action and inaction in organic matter have been brought respectively into relation with the functions of the several compounds in the organic system. The fact that the albumens are all active may be of some importance.

The nature of rotatory power and its dependence upon chemical constitution are next discussed, with especial reference to the theories of Pasteur, Le Bel, and Van't Hoff. The conclusion of the last-mentioned chemist that optically active substances invariably contain one or more asymmetrical carbon atoms, and the converse proposition that substances containing no asymmetrical carbon atoms display no optical activity, are not in opposition to any known facts. But Van't Hoff admits that not all bodies containing asymmetrical carbon atoms are optically active. The physical laws of circular polarisation are next laid down, the amount of rotation being shown to be dependent on the thickness of the medium and on the wave-length of the transmitted ray. These and connected considerations lead to the actual process for determining specific rotation. Here the various kinds of apparatus used are described and carefully figured; first, such as merely indicate the direction of the rotation as right or left, and such as in addition measure its quantity. The latter are divided into two classes: the polariscopes or polaristrometers, which are applicable to all optically active substances, and the saccharimeters, adapted for sugar. The account of these instruments, with the useful directions for their use, takes up the bulk of the remainder of the volume, and must be pronounced ably written with every regard to the useful precautions and niceties.

Mr. Steiner's appendix treats on the estimation of maltose and dextrine in malt worts and beers, and will be exceedingly useful to brewers.

The work is very carefully got up, and so far as we have observed is free from clerical and typographical errors.

The Dry Closet System: its Adaptation to the City of Hereford and other Urban Districts. By JAMES HAIN. Hereford: Hereford Times Office.

THE author of this pamphlet very sensibly protests against the proposed establishment of an irrigation farm as a method of disposing of the sewage of the city of Hereford. But he is equally unfavourable to precipitation, declaring it "a chemical impossibility to prepare by precipitation from sewage a manure which shall pay the cost of its production when its true commercial value is found either by practical experience or trustworthy analysis." He objects, in fact, to the water-closet system altogether, and recommends in preference dry closets. Unlike Mr. Moule and others, however, he proposes to absorb the excreta, not in coal-ashes, dry earth, or the like, but in a mixture of "equal quantities of peat charcoal dust and hot air-dried phosphate of lime, containing about 37 to 39 per cent of phosphoric acid,"—a composition which he pronounces an "effective and most valuable deodoriser." He recommends also the addition of a few handfuls of vitrified shoddy to be placed in each pail each time it is replaced to receive the excreta. That the analytical value of the manure thus produced will be greater than that of an ordinary dry-closet system where the faeces are received in clay, &c., is a simple truism, but the working cost must be increased in the same proportion. When the contents of the pails are collected together, he would add sulphuric acid, so as to dissolve the phosphate, yielding a manure

which would "contain about 20 per cent soluble phosphates, 8 to 9 per cent insoluble phosphates, and 1 to 2 per cent of ammonia." The kind of phosphate which the author has in view appears to be coprolites.

Suppose we take a mixture of equal parts of the best Cambridge coprolite at 66 per cent tricalcic phosphate and of peat charcoal, we shall have only 33 per cent total phosphate to begin with, and add to each 100 lbs. of the mixture the, say, 30 lbs. of sulphuric acid necessary to dissolve the phosphate, we shall have only a total of 25 per cent tricalcic phosphate to work upon, even if we overlook the fact that the absorbed fecal matters must reduce the relative proportion of the other constituents present. But to obtain 20 per cent soluble phosphate and 8 or 9 per cent insoluble phosphate out of a total percentage of 25 phosphate is manifestly impossible, since about 30 per cent tricalcic phosphate will have to be completely dissolved to yield the 20 per cent soluble phosphate. It must further be remembered that sulphuric acid acts less advantageously upon phosphatic minerals if the latter have been previously mixed, say, with charcoal.

An analysis is given of the concentrated manure made by the Health Committee of the Manchester Corporation. In it we find present phosphoric anhydride 1.445 per cent = 3.177 tricalcic phosphate, and about 3.64 per cent ammonia. Now before us lies the analysis of a sewage manure made by precipitation containing tricalcic phosphate 4.61 and ammonia 1.94 per cent, whilst another sample from the same place—Aylesbury—is certified by a perfectly independent authority to contain 3.41 per cent of nitrogen. It does not appear, therefore, that the "pail-system" manure has any distinct advantage over that obtained by precipitation.

Nitroglycerin in Angina Pectoris.—By W. MURRELL, M.D., M.R.C.P. London: H. K. Lewis.

CONCERNING the physiological action of nitroglycerin, observers differ. Whilst some persons have experienced alarming symptoms from taking 2 drops of a one per cent solution in alcohol, others have taken quantities equal to 50 and even 100 such drops without any marked effect. In some cases it produces unpleasant effects even when handled. The author makes the alarming statement that small quantities are manufactured even in London,—an offence for which the Explosives Act provides no remedy at all adequate. It is a singular piece of inconsistency that while additional restrictions are proposed on the sale of poisons, explosives of the most dangerous kind can be purchased practically without restraint.

Dr. Murrell has used nitroglycerin with success in the treatment of angina pectoris. The details of the cases have a purely medical interest.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 11, March 13, 1882.

Double Decompositions of the Haloid Salts of Mercury.—M. Berthelot. A thermo-chemical paper, not admitting of useful abridgment.

Kinetic Theory of Gases and the Vibratory Condition of Matter.—A. Ledieu. The conclusions drawn in this long mathematical paper are: The present theory of gases presents at its origin a secondary kinetic hypothesis which is quite gratuitous, and three errors of principle. The theory of gases must be taken up anew *ab ovo* upon more rigorous bases, even though it may furnish less brilliant results.

As to the general kinetic hypothesis, it is not attacked in the present discussion. The vibratory state of the ultimate particles of matter is now incontestable, since it rests expressly upon the principle of the mechanical equivalence of heat, which is one of the best-established scientific truths.

Crystalline Gallium Oxychloride.—Lecoq de Boisbaudran.—In 1878 the author prepared and sealed up in a tube, a specimen of hydrated gallium chloride in the gelatinous state. Last summer it was found converted into a mass of crystals immersed in a liquid. On examination the liquid was found very acid. The crystals were of an octahedral form, their apices being truncated by small facets. They have no action upon polarised light, and are scarcely, if at all, soluble in water or in cold nitric acid. It dissolves slowly in cold hydrochloric acid, and immediately in caustic potassa. These crystals consist of one mol. of chloride with 12Aq, corresponding to that of aluminium, and two mols. of mono-hydrated oxide, corresponding to mono-hydrated alumina. The hydrochloric solution of the crystals gives a brilliant spectrum of gallium.

Tempering by Compression.—M. Clément. The author heats metals, and especially steel, to a cherry-red, compresses them strongly, and keeps up the pressure till the mass is perfectly cold. The metal acquires an excessive hardness, and a striking fineness of grain. Steel thus treated acquires a coercive force, which enables it to become magnetic. The durability of this property requires to be studied.

Compressibility of Gases.—E. Sarrau.—The author gives his results for carbonic acid, nitrogen, and marsh-gas. He is not aware of any experiment to verify the elements of the critical point as calculated for nitrogen and formene.

Boiling-Point of Zinc.—J. Violle.—The author's experiments, several times repeated, show a temperature of 930°.

Hydro-dynamic Experiments (Note 4).—C. Decharme.—The author produces, by means of liquid currents, an imitation of the rings of Nobili, as obtained with electric currents. The author proceeds as follows:—Upon a horizontal plate of glass covered with a thin and uniform layer of red lead, barium sulphate, or any other insoluble powder held in suspension in water, he lets fall from a graduated glass tube a slender stream of water. The tube is held vertically at the height of 0.01 to 0.10 metre above the plate. These rings do not display the iridescent colours of Nobili's rings, but this distinction is not absolute.

Apparatus for Regulating the Flow of a Gas at any Pressure.—J. Ville.—Not susceptible of useful abstraction.

Formation-heat of Hydro-ferrocyanic Acid and of certain Ferrocyanides.—M. Joannis.—Hydrocyanic acid is a true bibasic acid, very similar to hydrochloric acid in the quantities of heat which it liberates with the alkalies and alkaline earths.

Products of the Distillation of Resin.—A. Renard.—The portions which pass over about 150° comprise three hydrocarbons, a terebenthene, and two isomeric carbides, C₁₀H₁₈. Those going over between 154° and 157° appear to be a mixture of a terebic carbide, C₁₀H₁₆, and a hydrocarbide, C₁₀H₈.

The Titration of Tannin and Eriogallic Acid in Wines.—F. Jean.—The author evaporates on the sand-bath 100 or 50 c.c. of the wine, so as to reduce its bulk to a few c.c. He mixes the residue with dry, precipitated silica, and dries the whole in the stove at 60° to 70°. The mass is then powdered, placed in a small extracting apparatus, and exhausted with ether, mixed with a small quantity of hydrochloric ether. The ethereal solutions are evaporated in the water-bath, and the residue is taken up in 100 c.c. distilled water. In 10 c.c. of this solution

the tannin and the œnagallic acid are titrated with solution of iodine, according to the author's method indicated for the volumetric determination of astringent bodies (*Comptes Rendus*, 1876). The solution must be neutralised before adding bicarbonate of soda, so that the astringent acids may always be in presence of the same quantity of alkaline bicarbonate. The rest of the aqueous solution is then agitated in contact with a small excess of rasped hide to fix the tannin, strained, and the œnagallic acid is determined in 10 c.c. of the filtrate by means of the solution of iodine. The second result shows the œnagallic acid, and is deducted from the former, which represents the joint weight of tannin and œnagallic acid. The difference shows the volume of iodine solution, which corresponds to the tannin contained in the wine. The standard of the iodine solution is ascertained in reference to a known weight of pure tannin, and as the gallic acid acts upon the iodine in the same proportion as the tannin, it is easy to calculate both the tannin and the œnagallic acid contained in the wine.

Chloruration of Camphor; Formation of Camphor Bichloride.—P. Cazeneuve.—The author dissolves camphor in absolute alcohol, and when the solution is cold passes through it a current of dry chlorine for four or five days. The compound, when purified, forms prisms of an intense white, insoluble in water, soluble to any extent in hot alcohol. It liquefies in contact with the vapour of ether.

Gastric Digestion.—E. Duclaux.—The author has discovered in certain ferments of casein, a diastase capable of transforming this substance into a peptone, similar to those met with in the digestive canal.

Chemical Action of Different Metals upon the Heart of the Frog.—C. Richet.—The author in his present way of experimenting, finds no relation between the "toxicity" of metals, even of the same family, and their atomic weight. Lithium is more poisonous than sodium, and palladium than platinum. The results when tabulated, differ notably from those obtained with the gills of fishes. Hence the toxicity of a substance varies according to the tissue with which it comes in contact. Among the metallic chlorides, some, such as those of barium, calcium, strontium, and cerium, arrest the heart in systole; others, such as potassium, cesium, rubidium, ammonium, nickel, cobalt, and magnesium, stop it in diastole. The remaining chlorides arrest it in an intermediate position.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 2, 1882.

True Chemistry.—A study by M. E. Maumené.—The author discusses here the chemical action determined by heat between the elements of liquids and the mutual action of copper and sulphur. (We hope to return to this memoir.)

Electric Machines.—H. Valette.—An illustrated description of the Gramme machines.

No. 3, 1882.

This number contains no original chemical matter.

No. 4, 1882.

Differential Apparatus for Determining Ozone in the Air.—Dr. D. Tommasi.—The apparatus is formed of an aspirator fitted with a copper tube dividing at one end into two branches. To one of these is fitted, by means of caoutchouc tubing, a bulb tube, as commonly used for the determination of ammonia. To the other branch is attached a similar bulb-tube, fitted, on the side where the air enters, with a platinum tube 30 c.m. long by 1 c.m. in diameter, filled with platinum sponge. To use the apparatus, there is poured into the bulb tubes a known volume of a standard solution of sodium arsenite, and the platinum tube is heated by means of a gas or spirit flame.

The cock of the aspirator is then opened and air is allowed to pass slowly through. After a time the current of air is shut off, and the quantity of sodium arsenite formed in each bulb-tube is determined by means of a standard solution of potassium permanganate. Let x be the quantity of arseniate found in the apparatus without the platinum tube, and y the quantity found in the other, $x-y$ will represent the proportion of ozone in the air. In the first tube is determined, not merely the ozone, but all substances which may have an oxidising action upon sodium arsenite. In the apparatus fitted with the platinum tube are determined the oxidising products less the ozone, which is transformed into ordinary oxygen in its passage over the heated platinum sponge.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. x., Part 12.

Two Instruments for the Analysis of Milk.—Dr. A. Adam and A. Pinchon.—Adam uses for the analysis of milk, a burette fitted below with a glass cock, provided with two ball-shaped enlargements, and capable of being closed with a cork. This burette (the galactometer) is graduated below, and between the balls there is a mark up to which it holds 10 c.c. On the upper ball is a second mark, indicating 22 c.c. more, or in all 32 c.c. Ten c.c. of milk are sucked in, the cock is closed, and a little more than 22 c.c. of alcohol, ether, and ammonia in mixture are added. The instrument is shaken, when the alcoholic etheral liquid seizes the butter. The two strata are allowed to separate, and the lower one, which is now free from fat, is run out through the cock, and can be used for the determination of the caseine. The solution of fat is shaken up first with water and then with dilute acetic acid, which, after settling, is let off by the cock; a little more dilute acetic acid is then added, so that the solution of fat is in the ball. The ether and alcohol are then expelled by plunging the burette into hot water. The stratum of acid liquid is let off at the top, so that the liquid fat passes into the graduated part of the instrument and is there measured. The figures show the number of grammes of fat contained in a litre of milk. Pinchon takes advantage of the unequal expansion of normal milk, skimmed milk, and diluted milk on being heated from the common temperature to from 50° to 55°. He has constructed upon this principle an instrument with scales and tables.

Adulteration of Butter.—MM. Johanson, Mayer, and others.—In Holland, besides the more liquid portion of tallow, the oil of arachis (earth-nut oil) is largely used. Mayer recommends for the detection of spurious butter, Bell's process as modified by Estcourt. The specific gravity of the sample is taken at 100°, genuine butter having a higher specific gravity than other fats and oils. In Chicago, lard is largely mixed with butter.

Use of Strontianite for Obtaining Sugar from Molasses.—Prof. C. Scheibler.—A main advantage of substituting strontia for lime is that the saccharate of strontia is granular and not gelatinous, like the corresponding lime compound. Three mols. strontia are required to 1 mol. sugar. On the large scale the author considers it possible to precipitate 99 per cent of the sugar present in molasses as a strontia compound.

Vol. xi., Part 1.

Utilisation of the Refuse Waters of Manufactures in Artificial Meadows in Lüneburg.—Carl Drewsen.—The author describes the application of the waste-waters of a paper mill for the irrigation of heath-land and sands, near Celle.

Action of Vegetation upon the Quantity of Substances withdrawn from the Soil by Rainfall.—E. W. Prevost.—From the *Journal of the Chemical Society*.

Studies on the Weathering of Orthoclase.—Julius Stocklassa.—The author divides the weathering-process into three stages. In the first occur decrease of hardness, increase of the proportion of water, and separation of ferric hydroxide. In the second stage there are formed silicates readily soluble in weak acids; alkalis, chiefly soluble in concentrated hydrochloric acid, increase; the density decreases, and the moisture increases. In the third stage, the outer layers are converted into China clay, whilst the silicates are leached out.

Power of Certain Salts to Arrest Ammonia.—Dr. A. Morgen.—Gypsum and magnesium chloride are especially efficacious in preventing the escape of ammonium carbonate. Magnesium sulphate, kainite, and kieserite may also be used with advantage where they can be procured cheaply.

The Value of Cesspool Manure.—Prof. F. Soxhlet.—The author gives analyses of poudrette made from the contents of the cesspools used for receiving excreta in Stuttgart, Heidelberg, and Augsburg, and the closet-liquid of Munich.

Action of Chili Saltpetre, Common Salt, and Potassium Chloride in the Soil.—C. F. A. Tuxen.—All these salts have a depressing effect on the absorption of ammonia and potassa; they convey these constituents of plant-food lower down into the earth, and prevent their appropriation by the arable layer. On the other hand, phosphoric acid is retained by the soil to a greater extent in the presence of sodium and potassium salts.

Manurial Experiments with Superphosphate and Bone-dust of Different Sizes of Grains.—Prof. F. Farsky.—In calcareous soils coarse superphosphate seems preferable to fine. Fine bone-dust also appeared to give a less satisfactory result than the coarser kinds.

The Excretion of Gaseous Nitrogen from the Animal Body.—Prof. J. Seegen, J. Nowak, and Dr. H. Leo.—The two first-mentioned authorities contend that the animal organism eliminates a part of the nitrogen derived from the decomposition of the albumenoids in the gaseous state. Dr. Leo shows that such an exhalation, if it takes place at all, must be practically unimportant in extent.

Electric Researches on Vegetable and Animal Tissues.—A. J. Kunkel.—The author ascribes the electric phenomena recorded to the imbibition and exhalation of water by the organic tissues.

Chemical Difference between Living and Dead Protoplasm.—O. Loew and T. Bokorny.—The authors trace vitality to the tension of aldehyd groups in the molecule of living protoplasm, and death to their displacement.

Bulletin de la Société Chimique de Paris.

Tome 37, Nos. 3 and 4, 1882.

A Trichloric Propane.—P. van Romburgh.—The trichlorinated propane formed by the action of phosphorus perchloride upon acrolein hydrochlorate, is not ordinary trichloro-hydrin, but rather appears to be identical with that which takes its rise as an accessory product in the preparation of allylidene chloride. The products of its decomposition under the influence of potassa show with sufficient certainty that the constitutional formula of the body ought to be $\text{CH}_2\text{Cl}-\text{CH}_2\text{CHCl}_2$. This is a new proof in favour of the theory which regards acrolein hydrochlorate as β -chloro-propionic aldehyd.

Influence of Heat and of the Proportions of Glycerin upon the Decompositions of Oxalic Acid.—M. Lorin.—On causing the respective proportions of oxalic acid and of glycerin to vary, the decomposition of the oxalic acid and the proportions of formic acid vary also. The final product is a poly-formine, of composition varying according to the conditions of the experiment; sometimes a

mono-forming nearly pure, sometimes a diformine, or mixtures of these bodies. It is not impossible that glyceric triformine may be obtained in experiments of this kind.

Essence of Angelica.—Laurent Naudin.—The author has obtained from the essence of the seeds, a compound isomeric with the oil of turpentine, and which he names terebangeline.

Action of Zinc Powder upon Bichlorated Terebenthene.—Laurent Naudin.—This compound is violently decomposed at 100° by traces of zinc powder.

Die Chemische Industrie.

Vol. 5, No. 1.

This number does not contain any matter other than abstracts of patent specifications.

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. February, 1882.

This issue contains no chemical matter.

Journal de Pharmacie et de Chimie.

January, 1882.

Electric Exhibition: Congress of Electricians.—This paper is composed of matter with which the scientific world is already familiar.

Manageable Zone of Anæsthetic Agents and a New Method of Chloroformisation.—P. Bert.—The author points out that in the use of anæsthetics the margin between efficiency and danger is very narrow.

New Notes on the Strychnos which Furnishes the Curare of the Orinoco.—G. Planchon.—This memoir is of no chemical interest.

MEETINGS FOR THE WEEK.

MONDAY, 3rd.—Medical, 8.30.

Royal Institution, 5. General Monthly Meeting.
Society of Chemical Industry, 7.30. "The Chemical Technology of Jute Fibre," by C. F. Cross, B.Sc. Discussion on "Smoke Abatement."

Pathological, 8.30.
Tuesday, 4th.—Institute of Civil Engineers, 8.
Anthropological Institute, 8. "The Papuans and Polynesians," by C. Scahill Wake. "Rites and Customs in Old Japan," by C. Ploufoues.

Wednesday, 5th.—Geological, 8.
Pharmaceutical, 8.
Obstetrical, 8.

Thursday, 6th.—Chemical, 8. "Observations on the Action of Acetylic Chloride on Fumaric Acid," by W. H. Perkin.
"Note on a Convenient Apparatus for the Liquefaction of Ammonia," by J. Emerson Reynolds.
"Transformation of Urea to Cyanamide," by H. J. H. Fenton.
"Some Arguments in favour of Ladenburg's Prismatic Formula of Benzene," by M. K. Dutt.

Friday, 7th.—Geologists' Association, 8.

COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE-UPON-TYNE.

A PROFESSOR OF CHEMISTRY for this College will be elected on the 5th June, Salary £300, with two-thirds of the Lecture Fees and one-third of the Laboratory Fees of Students of the College. The appointment is open to competition, and candidates for the office are to apply (with testimonials) to Thos. Wood BURNING, Secretary to the College of Physical Science, Newcastle-upon-Tyne, before Saturday, the 29th April, from whom full particulars as to duties, &c., may be obtained.

A Thoroughly Competent Analytical Chemist is required to go abroad under a three years' engagement. Must be skilled in assaying and mineralogy. Age from 30 to 35 years. Salary £500 per annum. Must be prepared to enter upon his duties now.—Address copies of testimonials and references, with any details considered necessary, to S. H. R., care of Messrs. G. Street and Co., 30, Cornhill, London, E.C.

THE CHEMICAL NEWS.

VOL. XLV. No. 1167.

ON THE MOVEMENT OF GAS IN "VACUUM DISCHARGES."*

By WILLIAM SPOTTISWOODE, F.R.S., and J. FLETCHER MOUTON, F.R.S.

IN the preparation of tubes for our experiments it was often noticed that, after the exhaustion had been carried to a certain degree, the passage of a strong current had the effect of increasing the pressure. This appeared to be due to an expulsion of gas from the terminals themselves by the passage of the discharge. And accordingly the use of such currents from time to time during the process of exhaustion was adopted for making the vacuum more perfect and more permanent than otherwise would have been the case. On the other hand, it was also noticed that after the tube had been taken off the pump and sealed in the usual way, the passage of a strong current had in some instances the effect of decreasing the pressure. We thus met with two effects, apparently due to the same cause, but diametrically opposite in character.

The fact of the tube being on the pump or off it did not appear to be at all material to the question, because the first effect could be obtained when the tube was temporarily shut off by a stopcock. Nor indeed did either the first or the second effect depend upon the absolute pressure, although neither was observed except when the pressure was such as to approach the stage when Crookes's phosphorescence was produced.

These phenomena also reproduced themselves in another way. Some tubes, after having been completed and taken off the pump, showed a decreased pressure after a prolonged passage of a strong current, others an increased pressure, but among both classes tubes were not unfrequently found which recovered their original pressure after a period of rest or cessation of discharge.

Matters remained in this rather confused state until we observed, with more care than before, a tube of which the exhaustion was near the phosphorescent state, and of which both terminals were metallic cones, and consequently presented large surfaces for any action which might take place upon them.

In what may be considered to have been its normal condition this tube showed three or four large white striae; with a Crookes's space of considerable size round the negative terminal. On passing the discharge through the tube for some minutes the Crookes's space increased, the striae became fewer and feebler in illumination, the green phosphorescence began to show itself, and the discharge showed the usual signs of reduced pressure. On suddenly reversing the current the striae became again more numerous and more brightly illuminated, precisely as they would by an increase of pressure, while the other features of the discharge in a great measure resumed their original character; and not only so, but by a comparatively slow process, occupying many seconds in duration, the indications of increasing pressure continued still further, until they implied a pressure even beyond that at which the tube stood when the experiments began. At this reversal the discharge was repeated many times with the same result in every case. The amount of change in pressure indicated by the appearance on each reversal was found to depend within wide limits upon the duration of the previous discharge, or, what is the same thing, upon the amount of depression below the normal pressure indicated by the previous discharge.

The only explanation of these phenomena appears to be this,—that the effect of the discharge is actually to alter the pressure in the tube, not by any modification in the chemical composition of the gas, still less by anything that could be represented as a destruction of matter, but simply by driving occluded gas out of one terminal, and by drawing it in, or occluding it, at the other. On reversing the discharge the operation is reversed, and the occluded contents of one terminal are thrown along the tube to be occluded at the other. This view of the mechanism whereby the observed phenomena are produced is supported by the absence of these appearances when the terminals are comparatively small and the pressure is such that the occluded contents of the metallic mass forming one terminal would form only a small fraction of the total mass of gas in the tube; for in that case the pressure, and consequently the appearance of the discharge, would be affected only in an inappreciable degree by the injection of the contents of the terminal. It should also be added that, when the terminals are of unequal size, the effects are unequal, as might have been expected.

The phenomenon in question appears to have so important a bearing on the mechanism of the discharge itself that it becomes a question of great interest to determine whether the ejection takes place at the positive, and the occlusion at the negative, terminal, or *vice versa*. For this purpose we have devised a tube with three terminals, but have not yet had time to complete its construction or to make the experiment.

ON THE CONSERVATION OF SOLAR ENERGY.*

By C. WILLIAM SIEMENS, D.C.L., LL.D., F.R.S.,
Mem. Inst. C.E.

THE question of the maintenance of Solar Energy is one that has been looked upon with deep interest by astronomers and physicians from the time of La Place downward.

The amount of heat radiated from the sun has been approximately computed, by the aid of the pyrheliometer of Pouillet and by the actinometers of Herschel and others, at 18,000,000 of heat units from every square foot of its surface per hour, or, put popularly, as equal to the heat that would be produced by the perfect combustion every thirty-six hours of a mass of coal of specific gravity = 1.5 as great as that of our earth.

If the sun were surrounded by a solid sphere of a radius equal to the mean distance of the sun from the earth (95,000,000 of miles), the whole of this prodigious amount of heat would be intercepted; but considering that the earth's apparent diameter as seen from the sun is only seventeen seconds, the earth can intercept only the 250-millionth part. Assuming that the other planetary bodies swell the amount of intercepted heat by ten times this amount, there remains the important fact that 111,111,111 of the solar energy is radiated into space, and apparently lost to the solar system, and only 1,111,111 utilised.

Notwithstanding this enormous loss of heat, solar temperature has not diminished sensibly for centuries, if we neglect the periodic changes, apparently connected with the appearance of sun-spots that have been observed by Lockyer and others; and the question forces itself upon us how this great loss can be sustained without producing an observable diminution of solar temperature even within a human lifetime.

Amongst the ingenious hypotheses intended to account for a continuance of solar heat is that of shrinkage, or gradual reduction of the sun's volume suggested by Helmholtz. It may, however, be urged against this theory that the heat so produced would be liberated throughout its mass, and would have to be brought to the surface by

* A Paper read before the Royal Society, March 30th, 1882.

* A Paper read before the Royal Society.

conduction, aided perhaps by convection; but we know of no material of sufficient conductivity to transmit anything approaching the amount of heat lost by radiation.

Chemical action between the constituent parts of the sun has also been suggested; but here again we are met by the difficulty that the products of such combination would ere this have accumulated on the surface, and would have formed a barrier against further action.

These difficulties have led Sir Wm. Thomson, following up Mayer's speculation, to the suggestion that the cause of the maintenance of solar temperature might be found in the circumstance of meteorolites falling upon the sun from great distances in space, or with an acquired velocity due to such fall, and he shows that each pound of matter so imported would represent a large number of heat units depending upon the original distance. Yet the aggregate of material that would thus have to be incorporated with the sun would tend to disturb the planetary equilibrium, and must ere this have shortened our year to an extent exceeding that resulting from astronomical records and observation. In fact Sir William Thomson soon abandoned the meteoric hypothesis for that of simple transfer of heat from the interior of a liquid sun to the surface by means of convection currents, which latter hypothesis appears at the present time to be supported by Prof. Stokes and other leading physicists.

But if either of these hypotheses could be proved we should only have the satisfaction of knowing that the solar waste of energy by dissipation into space was not dependent entirely upon loss of its sensible heat, but that its existence as a luminary would be prolonged by calling into requisition a limited, though may be large, store of energy in the form of separated matter. The true solution of the problem will be furnished by a theory, according to which radiant energy which is now supposed to be dissipated into space, and irrecoverably lost to our solar system, could be arrested and brought back in another form to the sun itself, there to continue the work of solar radiation.

Some years ago it occurred to me that such a solution of the solar problem might not lie beyond the bounds of possibility; and although I cannot claim intimate acquaintance with the intricacies of solar physics, I have watched its progress, and have engaged also in some physical experiments bearing upon the question, all of which have served to strengthen my confidence and ripened in me the determination to submit my views, not without some misgiving, to the touchstone of scientific criticism.

For the purposes of my theory, stellar space is supposed to be filled with highly rarefied gaseous bodies, including hydrogen, oxygen, nitrogen, carbon, and their compounds, besides solid materials in the form of dust. This being the case, each planetary body would attract to itself an atmosphere depending for its density upon its relative attractive importance, and it would not seem unreasonable to suppose that the heavier and less diffusible gases would form the staple of these atmospheres; that, in fact, they would consist mostly of nitrogen, oxygen, and carbonic anhydride, whilst hydrogen and its compounds would predominate in space.

But the planetary system, as a whole, would exercise an attractive influence upon the gaseous matter diffused through space, and would therefore be surrounded by an interplanetary atmosphere, holding an intermediate position between the planetary atmospheres and the extremely rarefied stellar space.

In support of this view it may be urged that, in following out the molecular theory of gases as laid down by Clerk-Maxwell, Clausius, and Thomson, it would be difficult to assign a limit to a gaseous atmosphere in space, and, further, that some writers, among whom I will here mention only Grove, Humboldt, Zoellner, and Mattieu Williams, have boldly asserted the existence of a space filled with matter, and that Newton himself—as Dr. Sterry Hunt tells us in an interesting paper which has only just reached me—has expressed views in favour of such an assumption. Fur-

ther than this, we have the facts that meteorolites whose flight through stellar, or at all events through interplanetary space, is suddenly arrested by being brought into collision with our earth, are known to contain as much as six times their own volume of gases taken at atmospheric pressure; and Dr. Flight has only very recently communicated to the Royal Society the analysis of the occluded gases of one of these meteorolites taken immediately after the descent to be as follows:—

| | |
|-------------------------|-------|
| CO ₂ | 0.12 |
| CO | 31.88 |
| H | 45.79 |
| CH ₄ | 4.55 |
| N | 17.66 |
| 100.00 | |

It appears surprising that there was no aqueous vapour, considering there was much hydrogen and oxygen in combination with carbon; but perhaps the vapour escaped observation, or was expelled to a greater extent than the other gases by external heat when the meteorolite passed through our atmosphere. Opinions concur that the gases found occluded in meteorolites cannot be supposed to have entered into their composition during the very short period of traversing our atmosphere; but if any doubt should exist on this head, it ought to be set at rest by the fact that the gas principally occluded is hydrogen, which is not contained in our atmosphere in any appreciable quantity.

Further proof of the fact that stellar space is filled with gaseous matter is furnished by spectrum analysis, and it appears from recent investigation, by Dr. Huggins and others, that the nucleus of a comet contains very much the same gases found occluded in meteorolites, including "carbon, hydrogen, nitrogen, and probably oxygen," whilst according to the views set forth by Dewar and Liveing it also contains nitrogenous compounds such as cyanogen.

Adversely to the assumption that interplanetary space is filled with gases, it is urged that the presence of ordinary matter would cause sensible retardation of planetary motion, such as must have made itself felt before this; but assuming that the matter filling space is an almost perfect fluid not limited by border surfaces, it can be shown on purely mechanical grounds that the retardation by friction through such an attenuated medium would be very slight indeed, even at planetary velocities.

But it may be contended that if the views here advocated regarding the distribution of gases were true, the sun should draw to itself the bulk of the least diffusible, and therefore the heaviest gases, such as carbonic anhydride, carbonic oxide, oxygen, and nitrogen, whereas spectrum analysis has proved on the contrary a prevalence of hydrogen.

In explanation of this seeming anomaly it can be shown, in the first place, that the temperature of the sun is so high that such compound gases as carbonic anhydride and carbonic oxide could not exist within it, their point of dissociation being very much below the solar temperature; it has been contended, indeed, by Mr. Lockyer, that none of the metalloids have any existence at these temperatures, although as regards oxygen Dr. Draper asserts its existence in the solar photosphere: there must be regions, however, outside that thermal limit, where their existence would not be jeopardised by heat, and here great accumulation of these comparatively heavy gases that constitute our atmosphere would probably take place, were it not for a certain counterbalancing action.

I here approach a point of principal importance in my argument, upon the proof of which my further conclusions must depend.

The sun completes one revolution on its axis in 25 days, and its diameter being taken at 882,000 miles, it follows that the tangential velocity amounts to 1.25 miles per second, or to 4.41 times the tangential velocity of our earth. This high rotative velocity of the sun must cause

an equatorial rise of the solar atmosphere, to which Mairau, in 1731, attributed the appearance of sodical light. La Place rejected this explanation on the ground that the sodical light extended to a distance from the sun exceeding our own distance, whereas the equatorial rise of the solar atmosphere due to its rotation could not exceed 9-20ths of the distance of Mercury. But it must be remembered that La Place based his calculation upon the hypothesis of an empty stellar space (filled only with an imaginary ether), and that the result of solar rotation would be widely different if it was supposed to take place within a medium of unbounded extension. In this case pressures would be balanced all round, and the sun would act mechanically upon the floating matter surrounding it in the manner of a fan, drawing it towards itself upon the polar surfaces, and projecting it outward in a continuous disk-like stream.

By this fan action hydrogen, hydrocarbons, and oxygen are supposed to be drawn in enormous quantities toward the polar surfaces of the sun; during their gradual approach they will pass from their condition of extreme attenuation and extreme cold to that of compression, accompanied with rise of temperature, until on approaching the photosphere they burst into flame, giving rise to a great development of heat, and a temperature commensurate with their point of dissociation at the solar density. The result of their combustion will be aqueous vapour and carbonic anhydride or oxide, according to the sufficiency or the insufficiency of oxygen present to complete the combustion, and these products of combustion in yielding to the influence of centrifugal force will flow toward the solar equator, and be thence projected into space.

The next question for consideration is, What would become of these products of combustion when thus rendered back into space? Apparently they would gradually change the condition of stellar material, rendering it more and more neutral; but I venture to suggest the possibility, nay the probability, that solar radiation would, under these circumstances, step in to bring back the combined materials to a condition of separation by a process of dissociation carried into effect at the expense of that solar energy which is now supposed to be lost to our planetary system.

According to the law of dissociation as developed by Bunsen and Sainte-Claire Deville, the point of dissociation of different compounds depends upon the temperature on the one hand, and upon the pressure on the other. According to Sainte-Claire Deville the dissociation tension of aqueous vapour at atmospheric pressure, and at 2800°C ., is 0.5, or only half of the vapour can exist as such, its remaining half being found as a mechanical mixture of hydrogen and oxygen, but that with the pressure the temperature of dissociation rises and falls, as the temperature of saturated steam rises and falls with its pressure. It is therefore conceivable that the temperature of the solar photosphere may be raised by combustion to a temperature exceeding 2800°C ., whereas dissociation may be effected in space at comparatively low temperatures.

But these investigations had reference only to heats measured by means of pyrometers, but do not extend to the effects of radiant heat. Dr. Tyndall has shown by his exhaustive researches that vapour of water and other gaseous compounds intercept radiant heat in a most remarkable degree, and there is other evidence to show that radiant energy from a source of high intensity possesses a dissociating power far surpassing the measurable temperature to which the compound substance under its influence is raised. Thus carbonic anhydride and water are dissociated in the leaf-cells of plants, under the influence of the direct solar ray at ordinary summer temperature; and experiments in which I have been engaged for nearly three years* go to prove that this dissociating action is

obtained also under the radiant influence of the electric arc, although it is scarcely perceptible if the source of radiant energy is such as can be produced by the combustion of oil or gas.

The point of dissociation of aqueous vapour and carbonic anhydride admits, however, of being determined by direct experiment. It engaged my attention some years ago, but I have hesitated to publish the qualitative results I then obtained, in the hope of attaining to quantitative proofs.

These experiments consisted in the employment of glass tubes, furnished with platinum electrodes, and filled with aqueous vapour or with carbonic anhydride in the usual manner, the latter being furnished with caustic soda to regulate the vapour pressure by heating. Upon immersing one end of the tube charged with aqueous vapour in a refrigerating mixture of ice and chloride of calcium, its temperature at that end was reduced to -32°C ., corresponding to a vapour pressure, according to Regnault, of 1-1800th of an atmosphere. When so cooled no slow electric discharge took place on connecting the two electrodes with a small induction coil. I then exposed the end of the tube projecting out of the freezing mixture, backed by white paper, to solar radiation (on a clear summer's day) for several hours, when upon again connecting up to the inductorium, a discharge, apparently that of a hydrogen vacuum, was obtained. This experiment being repeated furnished unmistakable evidence, I thought, that aqueous vapour had been dissociated by exposure to solar radiation. The CO_2 tubes gave, however, less reliable results. Not satisfied with these qualitative results, I made arrangements to collect the permanent gases so produced by means of a Sprengel pump, but was prevented by lack of time from pursuing the inquiry, which I purpose, however, to resume shortly, being of opinion that, independently of my present speculation, the experiments may prove useful in extending our knowledge regarding the laws of dissociation.

Assuming, for my present purpose, that dissociation of aqueous vapour was really effected in the experiment just described, and, assuming, further, that stellar space is filled with aqueous and other vapour of a density not exceeding the 1-2000th part of our atmosphere, it seems reasonable to suppose that its dissociation would be effected by solar radiation, and that solar energy would thus be utilised. The presence of carbonic anhydride and carbonic oxide would only serve to facilitate the decomposition of the aqueous vapour by furnishing substances to combine with nascent oxygen and hydrogen. By means of the fan-like action resulting from the rotation of the sun, the vapours dissociated in space to-day would be drawn towards the polar surfaces of the sun to-morrow, be heated by increase in density, and would burst into flame at a point where both their density and temperature had reached the necessary elevation to induce combustion, each complete cycle taking, however, years to be accomplished. The resulting aqueous vapour, carbonic anhydride, and carbonic oxide would be drawn towards the equatorial regions, and be then again projected into space by centrifugal force.

Space would, according to these views, be filled with gaseous compounds in process of decomposition by solar radiant energy, and the existence of these gases would furnish an explanation of the solar absorption spectrum, in which the lines of some of the substances may be entirely neutralised and lost to observation. As regards the heavy metallic vapours revealed in the sun by the spectroscopic, it is assumed that these form a lower and denser solar atmosphere, not participating in the fan-like action which is supposed to affect the light outer atmosphere only, in which hydrogen is the principal factor.

Such a dense metallic atmosphere could not participate in the fan action affecting the lighter photosphere, because this is only feasible on the supposition that the density of the in-flowing current is—at equal distances from the gravitating centre—equal or nearly equal to the outflowing

* See *Proc. Roy. Soc.*, vol. xxii, March, 1880; and a paper read before Section A of the British Association, September 1, 1881, and ordered to be printed in the Report.

current. It is true that the products of combustion of hydrogen and carbonic oxide are denser than their constituents, but this difference may be balanced by their superior temperature on leaving the sun, whereas the metallic vapours would be unbalanced, and would therefore obey the laws of gravitation, recalling them to the sun. On the surface of contact between the two solar atmospheres intermixture, induced by friction, must take place, however, giving rise perhaps to those vortices and explosive effects which are revealed to us by the telescope, and have been commented on by Sir John Herschel and other astronomers. Some of the denser vapours would probably get intermixed and carried away mechanically by the lighter gases, and give rise to that cosmic dust which is observed to fall upon our earth in not inappreciable quantities. Excessive intermixture would be prevented by the intermediary neutral atmosphere, the penumbra.

As the whole solar system moves through space at a pace estimated at 150,000,000 of miles annually (being about one-fourth of the velocity of the earth in its orbit), it appears possible that the condition of the gaseous fuel supplying the sun may vary according to its state of previous decomposition, in which other heavenly bodies may have taken part. May it not be owing to such differences in the quality of the fuel supplied that the observed variations of the solar heat may depend? and may it not be in consequence of such changes in the thermal condition of the photosphere that sun-spots are formed?

The views here advocated could not be thought acceptable unless they furnished at any rate a consistent explanation of the still somewhat mysterious phenomena of the zodiacal light and of comets. Regarding the former we should be able to return to Mairan's views, the objection by La Place being met by a continuous outward flow from the solar equator. Luminosity would be attributable to particles of dust emitting light reflected from the sun, or by phosphorescence. But there is another cause for luminosity of these particles, which may deserve a passing consideration. Each particle would be electrified by gaseous friction in its acceleration, and its electric tension would be vastly increased in its forcible removal, in the same way as the fine dust of the Desert has been observed by Werner Siemens to be in a state of high electrification on the apex of the Cheops Pyramid. Would not the zodiacal light also find explanation by slow electric discharge backward from the dust towards the sun? and would the same cause not account for a great difference of potential between the sun and earth, which latter may be supposed to be washed by the solar radial current? May not the presence of the current also furnish us with an explanation of the fact that hydrogen, while abounding apparently in space, is practically absent in our atmosphere, where aqueous vapour, which may be partly derived from the sun, takes its place? An action analogous to this, though on a much smaller scale, may be set up also by terrestrial rotation giving rise to an electrical discharge from the outgoing equatorial stream to the polar regions, where the atmosphere to be pierced by the return flood is of least resistance.

It is also important to show how the phenomena of comets could be harmonised with the views here advocated, and I venture to hope that these occasional visitors will serve to furnish us with positive evidence in my favour. Astronomical physicists tell us that the nucleus of a comet consists of an aggregation of stones similar to meteoric stones. Adopting this view, and assuming that the stones have absorbed in stellar space gases to the amount of six times their volume, taken at atmospheric pressure, what, it may be asked, will be the effect of such a mass of stone advancing towards the sun at a velocity reaching in perihelion the prodigious rate of 366 miles per second (as observed in the comet of 1845), being twenty-three times our orbital rate of motion. It appears evident that the entry of such a divided mass into a comparatively dense atmosphere must be accompanied by a rise of temperature by frictional resistance, aided by attractive condensation. At

a certain point the increase of temperature must cause ignition, and the heat thus produced must drive out the occluded gases, which in an atmosphere 3000 times less dense than that of our earth would produce $6 \times 3000 = 18,000$ times the volume of the stones themselves. These gases would issue forth in all directions, but would remain unobserved except in that of motion, in which they would meet the interplanetary atmosphere with the compound velocity, and form a zone of intense combustion, such as Dr. Huggins has lately observed to surround the one side of the nucleus, evidently the side of forward motion. The nucleus would thus emit original light, whereas the tail may be supposed to consist of stellar dust rendered luminous by reflex action produced by the light of the sun and comet combined, as foreshadowed already by Tyndall, Tate, and others, starting each from different assumptions.

These are in brief the outlines of my reflections regarding this most fascinating question, which I venture to put before the Royal Society. Although I cannot pretend to an intimate acquaintance with the more intricate phenomena of solar physics, I have long had a conviction, derived principally from familiarity with some of the terrestrial effects of heat, that the prodigious and seemingly wanton dissipation of solar heat is unnecessary to satisfy accepted principles regarding the conservation of energy, but that it may be arrested and returned over and over again to the sun, in a manner somewhat analogous to the action of the heat recuperator in the regenerative gas furnace. The fundamental conditions are—

1. That aqueous vapour and carbon compounds are present in stellar or interplanetary space.
2. That these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation.
3. That these dissociated vapours are capable of being compressed into the solar photosphere by a process of interchange with an equal amount of reassociated vapours, this interchange being effected by the centrifugal action of the sun itself.

If these conditions could be substantiated we should gain the satisfaction that our solar system would no longer impress us with the idea of prodigious waste through dissipation of energy into space, but rather with that of well-ordered self-sustaining action, capable of perpetuating solar radiation to the remotest future.

ON THE SULPHATES OF ALUMINIUM.

By SPENCER UMPREVILLE PICKERING, B.A. Oxon.,
Assistant Master at Highgate School, and Chemical Lecturer
at Bedford College.

(Concluded from p. 135.)

VIII. Decomposition of Basic Sulphates from Basic Solutions.

WHEN a solution containing a basic sulphate of aluminium is left in the cold, it will continue to deposit a basic precipitate for many days, and even weeks. In order to ascertain whether this deposit thus formed is constant in composition or not, the filtrate from experiment 57 was allowed to stand for ten days, and the deposit then analysed. It was found to contain 66.169 per cent of alumina, or exactly the same amount as the original precipitate did. The filtrate from experiment 56 when similarly treated for a period of five days, gave a deposit containing 67.705 per cent of alumina, the original precipitate in this case having been less basic, since it contained only 66.149 per cent of alumina. A deposit obtained from a solution of aluminium sulphate, to which ammonia had been added in insufficient quantities to produce a permanent precipitate, has already been mentioned as containing 67.75 per cent of alumina.

Rammelsberg (*Pogg. Ann.*, 43, 583), repeating an experiment of Bauer's, kept a basic solution of aluminium sulphate for several years, and found that a deposit of crystalline appearance which had formed during that time contained 49.36 per cent of alumina. The author of the present paper has not been able to repeat this experiment exactly, but the above deposits gave no indications of crystalline structure under the microscope, and a rather strong basic solution on being allowed to stand for two months gave a deposit which might possibly have had some claims to being crystalline, but which on treatment with water dissolved to such a considerable extent that it evidently contained some of the normal salt mixed up with the basic deposit. On being repeatedly ground up and washed with water till it yielded but little sulphate to the wash-water, it was found to contain 66.54 per cent of alumina. The low percentage obtained by Rammelsberg, and the crystalline appearance noticed by him, is, therefore, in all probability due to the presence of some of the normal sulphate.

The above experiments, therefore, show that the deposits thus obtained are variable, and are not definite in composition.

IX. Basic Solutions diluted with Water.

When a solution containing a basic sulphate is diluted with water, a precipitate is obtained, increasing in amount as the quantity of water added is greater. In order to ascertain whether the precipitate thus formed was constant in composition or not the experiments given in Table V. were performed. In the first three experiments here quoted the solution employed was obtained by dissolving zinc in a strong solution of the normal sulphate at 100° until the first cloudiness appeared. Portions of this solution were diluted with 4, 100, and 500 volumes of cold water, and, as may be seen from the numbers in the third column, the precipitates thus thrown down increased regularly in basicity as the dilution was greater, although the amount of variation was by no means great. The last two experiments given in the table were performed with a solution obtained in a similar way to the above, except that only about one-half as much zinc had been allowed to dissolve in this case, and consequently the solution here was less basic; the results, however, indicate a variation in the same direction as the preceding ones do, although it is here rather greater, and both the precipitates are considerably less basic than the former ones.

Hence, on diluting basic solutions with water, the composition of the precipitate obtained varies with the extent of the dilution, and also with the basicity of the solution taken.

TABLE V.
Basic Solutions diluted with Water.

| | Amount of Water added. | Approximate Amount of the total Al_2O_3 Precipitated. | Percentage of Al_2O_3 in the Anhydrous Precipitate. |
|-----|------------------------|---|---|
| 63. | 4 volumes | 32 per cent | 68.067 |
| 64. | 100 " | 44 " | 68.435 |
| 65. | 500 " | 95 " | 68.994 |
| 66. | 25 " | 42 " | 65.312 |
| 67. | 300 " | 60 " | 67.361 |

X. Attempts to Prepare an Acid Sulphate.

In order to ascertain whether aluminium is capable of combining with more sulphuric acid than exists in the normal sulphate, a solution of this latter salt was allowed to evaporate spontaneously after an equivalent of sulphuric acid had been added to it; but in this case, as well as in others in which the amount of acid present was increased, the only solid which ever made its appearance in the liquid consisted of the crystallised normal sulphate. Again, on boiling down some aluminium sulphate with a large excess of sulphuric acid until the whole solidified, an amorphous mass was obtained, and this, after thorough washing with cold water, in which it dissolved very

slowly, proved to be nothing but the anhydrous or partially hydrated normal salt. Hence, all attempts to obtain an acid sulphate of aluminium have so far been unsuccessful.

XI. Conclusion.

The experiments which have been detailed in the present communication tend to prove in the case of the sulphates of aluminium what a previous paper has proved in the case of the ferric sulphates. If they are considered satisfactory we must conclude that the whole body of basic sulphates of aluminium must be denied a place in our lists of definite chemical compounds; and it must be remembered that the present experiments are not mere repetitions of those of other chemists, proving that the results obtained are not always concordant, but that (in most of the cases at any rate) they clearly show that the substances actually obtained exhibit a constant variation in chemical composition with a variation of some of the physical conditions under which they are obtained.

In conclusion, it may be well to give a list of the sulphates which have been said to exist together, with the references to the papers treating of them.

1. $Al_2O_3 \cdot 2SO_3$, containing 38.954 per cent of alumina. Maus, *Pogg. Ann.*, xi., 80.* Marguerite, *Comptes Rendus*, xc., 1354; Göbel, *Schw.*, 60, 401.
2. $Al_2O_3 \cdot 3SO_3$, containing 45.97 per cent of alumina. Göbel, *Jahrbuch der Chemie und Physik*, 1830, iii.; Mill, *Quart. Journ. Sci.*, i., 1828, 382.
3. $Al_2O_3 \cdot 4SO_3$, containing 48.906 per cent of alumina. Rammelsberg, *Pogg. Ann.*, 43, 583.
4. $Al_2O_3 \cdot SO_3$, containing 56.062 per cent of alumina. Maus (*loc. sup. cit.*); Debray, *Bull. Soc. Chim.*, (II.), vii., 9; Stromeyer, *Schweiger. Journ.*, 10, 424. See also analyses of Websterite, or aluminate.
5. $4Al_2O_3 \cdot 3SO_3$, containing 62.989 per cent of alumina. Debray (*loc. sup. cit.*)
6. $3Al_2O_3 \cdot 2SO_3$, containing 65.687 per cent of alumina. Lassaigue, *Ann. de Chemie*, 24, 97.
7. $5Al_2O_3 \cdot 3SO_3$, containing 68.023 per cent of alumina. Debray (*loc. sup. cit.*); Marchaud, *Erd. Journ. Prakt. Chem.*, 32, 506.
8. $2Al_2O_3 \cdot SO_3$, containing 71.851 per cent of alumina. Phillips, "Annals of Philosophy," iv., 260; Steinberg, *Erd. Journ. Prakt. Chem.*, 32, 495.
9. $5Al_2O_3 \cdot 2SO_3$, containing 76.737 per cent of alumina. Marchaud (*loc. sup. cit.*); Erdmann, *Jahrbuch der Chemie und Physik*, 1831 (ii.).

An examination of the above papers is eminently satisfactory, except from the point of view suggested by the experiments in the present communication. Special mention has already been made of the most important of them where occasion for doing so occurred. In most cases one chance experiment and one single analysis are considered by the authorities here quoted as sufficient proof of the substance obtained being definite in composition, and in a great many of them the analysis of some more or less complicated mineral is alone quoted; but the fact that some formula may be tacked on to a mineral representing it as containing a certain basic salt can scarcely, in the opinion of the author of this paper, be considered as a satisfactory proof that this basic salt exists as a definite chemical compound.

Nomenclature of the Proximate Derivatives of Carbonic Acid.—A. Berthsen.—The author proposes the following principles: The acids with the carbonyl group are to be named "carbonyl" acids; those with the thiocarbon group CS are "thiocarbon" acids; the isomers of the carbaminic and thiocarbaminic acid are to be "imido-carbon" acids; the group $CONH_2$ is rendered by carbamin; $CSNH_2$, thiocarbamin; and $C(NH)NH_2$, imido-carbamin.—*Liebig's Annalen*.

* Misquoted in "Gmelin," iii., 328, and "Watts's Dictionary of Chemistry," ii., 579, as $2Al_2O_3 \cdot 3SO_3$.

NEW FILTERING APPARATUS.*

By P. CASAMAJOR.

In the year 1875, I published descriptions of two funnels for filtering under pressure, one of which was to be applied to the method of filtration proposed by Dr. H. Carmichael, and described in Crookes's "Select Methods of Chemical Analysis," (page 429). In this method, the liquid is separated from the precipitate by the agency of a small disk of filtering paper, held against the perforated surface of a vessel, the interior of which communicates with an aspirator. This vessel, having the paper disk held against it, is placed directly in a platinum or porcelain dish, in which the precipitate is to be afterwards heated.

Dr. Carmichael made his vessel, communicating with the aspirator, of glass, but his method for making perforations on the flat side of this vessel was, to say the least, so very difficult, that very few chemists had succeeded in applying his method of filtration. The funnel which I used for the purpose was of glass, the shape being that of a Platner's blowpipe mouth-piece. The mouth of the funnel was closed by a small disk of filter paper, resting on a perforated platinum plate. This plate was also circular and slightly smaller than the disk of filtering paper. Both the perforated plate and disk of filter paper were held tightly against the funnel by the suction of an aspirator.

In the same paper there is a description of another funnel to be used with the same filter, but, in using this

ated plate, and around its edges, and form a very efficient filtering medium.

This aspirator, consisting of a vertical tube, was found so simple and convenient, that I tried to apply it to the funnel first described, which is used in Dr. Carmichael's system of filtration, but the experiments were not successful. In funnels of this shape, the perforated plate and disk of filter paper are held on the under side of the funnel by the suction of an aspirator. Whenever the aspirator ceases to act, the platinum plate and sheet of paper drop down.

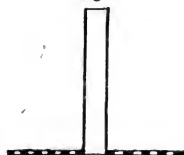
The difficulty experienced was due to this: that the paper filter cannot be held in position unless there is a volume of liquid in the vertical tube, while, at the same time, the vertical tube cannot be filled unless the paper filter is held tightly against the funnel.

These are the antecedents of the filter and the aspirator which I now propose to describe.

In this new filtering apparatus, the filtering medium is laid on a perforated plate, provided with a tube open at both ends, which is firmly attached to the plate, over a hole of the same size as the tube. Figure 1 shows a section of the plate, with the tube attached.

This perforated plate is laid on the bottom of a dish or crucible made of platinum, porcelain, or any other suitable material. The upper portion of the tube is connected with an aspirator, and there must be a small space left between the under surface of the plate and the bottom of the vessel, to allow the filtered liquid to pass through the filtering medium. The liquid which passes into the space under the plate is removed through the tube by the action of the aspirator.

Fig. 1.



funnel, whose shape is that of a large thistle tube, the perforated platinum plate is placed on the bottom of the funnel, and, over it, the small disk of filter paper, the edges of which slightly overlap those of the perforated plate. The liquid to be filtered is poured in the funnel. With this funnel, any ordinary aspirator may be used, but I have always used, in connection with it, a simple aspirator consisting of a straight vertical tube of small diameter, attached to the bottom of the funnel. I again call attention to this particular form of aspirator in a subsequent paper,† published shortly after, in which are given fuller details as to its use.

The vertical tube acts by the weight of the column of water, which it holds suspended below the liquid. Its use was made possible by the fact that, when there was no more liquid above the moist disk of filter paper, this became impervious to air, and the column of liquid in the vertical tube continued to be held in suspension, but any additional liquid poured in the funnel went through the paper disk without any difficulty.

I pointed out that, instead of using a disk of filter paper, paper pulp or asbestos pulp could be poured into the funnel. The excess of water would run out, and a layer of paper or of asbestos would be left on top of the perfor-

Fig. 2.

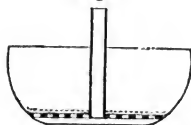


Figure 2 shows the perforated plate in position at the bottom of a platinum or porcelain dish. The filtering medium rests on top of the perforated plate, and is indicated by a fine dotted line. If the bottom of the vessel should be perfectly flat, it would be necessary to make the perforated plate slightly curved, with the concavity turned downward, to allow a space between the plate and the bottom of the vessel.

The filtering medium may be a piece of filter-paper, or it may be deposited in the form of paper pulp or asbestos pulp, as already mentioned. If a paper filter is used there should be a hole in it to let the tube go through. The perforations in the plate should begin at a certain distance from the tube, so that every portion of the perforated surface may be covered with paper.

It is a very simple matter to make this perforated plate with its tube. Any jeweller can make a tube from platinum foil and solder the joint with coin gold, which is sufficiently infusible for most purposes, and the tube can be soldered to the plate with the same material. This is the readiest way, as it is next to impossible in this country to have work of this kind done entirely of platinum.

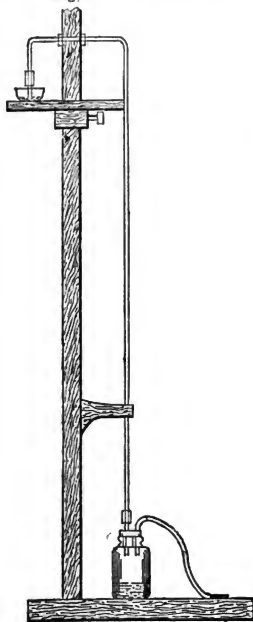
We may also form this piece of apparatus in two portions. Any metal-spinner can turn, on a platinum plate, a tube 5 or 6 millimetres long, and, over this short tube a platinum tube about 3 centimetres long can be firmly placed. It is very important that the long platinum tube should come down as low as possible over the shorter tube, so that the pulp of paper or asbestos may be deposited over the joint.

It is almost useless to mention that the weight of the

* From the *Journal of the American Chemical Society*, vol. iii.
† *American Chemist*, v., 440, and *Chemical News*, xxiii., 40.
‡ Funnel with auxiliary vertical tube; see *American Chemist*, vi., 124, and *Chemical News*, xxiii., 184.

perforated plate should be taken as part of the tare, with the weight of the platinum vessel, and of the asbestos, when a pulp of this material is used. The perforated plate remains in the crucible or dish, while the precipitate is heated, and it is afterwards placed on the balance along with the precipitate. When asbestos is used, the requisite quantity should be placed in the vessel in which the precipitate is to be heated, the perforated plate should be added, and the whole sufficiently heated. The vessel and all the contents should then be placed on the balance so as to obtain the total tare. If the platinum tube is not

Fig. 3.



soldered to the perforated plate, it may with great convenience be left out of the count, as it may be easily removed by holding down the perforated plate with a spatula, and pulling off the tubes after the filtration is over. The quantity of asbestos required is very slight. Dry asbestos, weighing 1 decigram, if sufficiently fine, can easily cover a perforated plate with a surface of 6 square centimetres (about 1 square inch.)

Very full details relating to asbestos filters may be found in an interesting paper of Mr. F. A. Gooch, read before the American Academy of Sciences, Feb. 13th, and pub-

lished in the *CHEMICAL NEWS*, vol. xxxvii., p. 181. The author does not seem to be aware that I had proposed the use of asbestos pulp in 1875, as mentioned above, by pouring the pulp over a perforated plate.

In the arrangement introduced by Mr. Gooch the filtered liquid is forced through asbestos, lying on the perforated bottom of a crucible, by the action of an aspirator. There is a tight joint formed around the crucible, by forcing it into a large rubber tube, which also fits tightly on the top of a glass funnel, in the manner proposed for porous earthenware cones by Prof. Munroe. There is no doubt that a very good aspirator for this filtering apparatus would be a straight glass tube having a small diameter, connected by a rubber tube with the stem of the glass funnel.

With the new form of filtering apparatus, having a perforated platinum plate with tube attached, any form of aspirator may be used, and there is no difficulty in using a vertical tube having a small diameter, like those already mentioned, in which the suction is caused by the weight of a column of the filtered liquid held in suspension. This aspirator with filter, shown in section, is represented in Fig. 3. The aspirator tube is bent twice at its upper end, and there terminates in a short vertical tube about 3 centimetres long, connected with the platinum tube, attached to the perforated plate by a rubber tube. The long vertical portion of this tube is connected at its lower end by a short rubber tube, with another glass tube passing through the cork of a bottle. Through the same cork passes another tube, by means of which the operator may start the liquid, and make it run into the long vertical tube.

To use this apparatus, if the perforated plate is covered with filter-paper, distilled water is poured in the platinum dish, represented in the figure, and the vertical tube is filled by sucking air from the bottle. When the tube remains filled with liquid, for even a few seconds, there is no fear of its becoming empty during the filtration. The bottle may be taken away and a beaker glass substituted. If the tube cannot be made to retain the liquid, it is best to pour some of the precipitate in the platinum dish, and this will make a sufficiently tight joint to keep the liquid in the long arm of the tube. By doing this some of the precipitate may at first be carried into the bottle, but very soon nothing but clear liquid remains in the glass tube. The glass bottle may then be taken away, and its liquid contents poured back into the platinum dish.

If instead of a sheet of paper the filtering medium is made from asbestos pulp, a certain portion of the pulp will inevitably pass through the glass tube at first. This will have to be poured back into the platinum dish, even if no portion of precipitate has gone through. If paper pulp is used, and only a small portion passes through without any of the precipitate, there is no necessity of pouring it back.

After the tube has once remained permanently filled with the filtered liquid no further difficulty will be experienced. The rest of the liquid to be filtered may be gradually poured in the platinum dish, and subsequently hot water is added to wash the precipitate.

After the operation is completed, if the platinum tube is slipped from the rubber tube which connects it with the aspirator, the water held in the platinum tube will fall back in the crucible. This is easily got rid of by subsequent evaporation, but this quantity of water, and that which remains below the platinum plate, may be mostly carried off through the aspirator by carefully removing the precipitate from a point on the edge of the paper disk, and lifting this up with the point of a needle just sufficiently to let air go in to clear the aspirator tube from liquid.

Formation-heat of Sulphocyanic Acid and of certain Sulphocyanides.—M. Joannis.—The formation-heat of the sulphocyanides are intermediate between the formation-heat of the iodides and of the corresponding bromides.—*Comptes Rendus*.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Anniversary Meeting, Thursday, March 30, 1882.

Prof. H. E. Roscoe, President, in the Chair.

THE PRESIDENT, in his annual address, congratulated the Fellows on the prosperous condition of the Society. 1175 names are now enrolled on the register of the Society. 87 original communications have been made to the Society during the past session. The Treasurer's report shows a balance of £1422 of income over expenditure.

The President then referred to the lecture "On the Unit Weight and Mode of Constitution of Compounds," delivered by Prof. ODLING on February 2, and at somewhat greater length to the Faraday lecture "On the Modern Development of Faraday's Conception of Electricity," delivered by Prof. HILMHOLTZ on April 5. The subjects of the advancement of chemical industry and the encouragement of technical scientific instruction in this country are matters which cannot fail to be of interest to the Society. The establishment, therefore, of a Society of Chemical Industry, with its monthly journal giving the most important applications of chemistry to the numerous branches of our national industries, must be a matter of hearty congratulation. The subject of technical scientific instruction has attracted the attention of the Government, and a Commission has been appointed to investigate the subject both on the Continent and in this country. In accepting an appointment on this commission the President felt that, though obliged to be absent from several meetings, he was acting in accordance with the best interests of the Society. The Commission has already visited Yorkshire and other parts of this country, Italy, and France; Germany, Belgium, and Switzerland remain to be visited. The President has also attended the meetings of the City and Guilds of London Institute, and has been consulted upon the arrangements of the new central technical college now building at South Kensington. The President then referred to some of the most important advances made in chemistry during the past year. As regards the variation in density of the halogens at high temperatures, Crafts and Meier also V. Meyer and Zublin, have shown that the molecules of gaseous chlorine are not dissociated at 1200°, but that nascent chlorine evolved from platinum chloride at the same temperature undergoes a diminution to $\frac{1}{2}$ Cl₂. Two molecules of chlorine (4 vols.) are dissociated into 1 molecule occupying 2 vols., and 2 semimolecules each occupying 2 vols. The one modification therefore bears to the other the same relation as regards density as oxygen bears to ozone. The case of bromine seems to be identical with that of chlorine. Mallet has observed that hydrofluoric acid gas has at 30° a density corresponding to H₂F₂; at 100° its density is represented by HF. Setterberg has investigated caesium and its salts, and has prepared 40 kilos. of pure rubidium alum, and 10 kilos. of pure caesium alum. His results confirm those already obtained by Bunsen. No metallic caesium can be obtained by the carbon reduction process. Electrolysis of the cyanide was, however, successfully employed. The President also referred to the recent researches of Dr. Brauner, communicated to the Society, on the cerite metals; the discovery of a British mineral containing yttrium, by Prof. Hartley; the recent researches of Beyer on the indigo group; the artificial production of caffeine from xanthin, by E. Fischer, &c.

Since the last Anniversary, the Society has lost two foreign members—Prof. Sainte-Claire Deville and M. V. Dessaignes; and eleven Fellows—A. E. Arnold, F. J. Barrett, E. Buckley, R. C. Clapham, R. Gerstl, J. Mackay, A. Freire Marreco, K. W. Thomas, J. S. Walton, A. Willis, and H. J. Zeld.

Prof. DEWAR moved the adoption of the Report of the

Council, and at the same time a hearty vote of thanks to the President for his able address and for the thorough manner in which he had discharged his duties during the past year.

This was seconded by Dr. HUGO MÜLLER, and carried by acclamation.

THE PRESIDENT in returning thanks said that he had felt most deeply the kindness with which he had been received by every Fellow since the time that he had been elected to the distinguished position he now held. He had tried to do his best during the past, and for the future if he could do anything to further the interests of the Society, they had only to call on their past President.

THE SECRETARY then read, in the absence of Dr. Russell, the Treasurer's Report.

Votes of thanks were passed to the Treasurer and the Auditors, the Officers and Council, and the Editor, Sub-editor, and Abstractors.

A ballot was then held for the election of Officers and Council. Dr. Messel and Mr. Maxwell-Lyte, the Scrutators, declared the following as duly elected, and the list was read from the Chair:—

President—Dr. J. H. Gilbert.

Vice-Presidents—F. A. Abel, Warren De la Rue, E. Frankland, J. H. Gladstone, A. W. Hofmann, W. Odling, Lyon Playfair, H. E. Roscoe, A. W. Williamson, A. Crum-Brown, J. Dewar, P. Griess, A. V. Harcourt, J. E. Reynolds, E. Schunck.

Secretaries—W. H. Perkin, H. E. Armstrong.

Foreign Secretary—Hugo Müller.

Treasurer—W. J. Russell.

Ordinary Members of Council—E. Atkinson, W. de W. Abney, F. D. Brown, F. R. Japp, H. McLeod, G. H. Makins, E. J. Mill, C. O'Sullivan, C. Schorlemmer, J. M. Thomson, W. Thorp, T. E. Thorpe.

The Society then adjourned till April 6th.

CORRESPONDENCE.

SUGAR ANALYSIS.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xlv., p. 86, is a letter from Dr. J. H. Tucker, taking exception to your review of his book on sugar analysis. Your reviewer found fault with the following statement of Dr. Tucker concerning Clerget's process:—"It must be remembered that the process is entirely inapplicable when any optically active body is present, besides cane-sugar or inverted sugar, as also if the invert sugar itself exists in an inactive condition as regards polarised light."

I entirely agree with your review in finding that this passage contains erroneous opinions concerning Clerget's process, and as the subject is one of great importance in the analysis of commercial sugars and refinery products, I propose to show what Clerget's process consists in, and why it is useful in correcting errors due to optically active bodies which may be found as impurities in commercial sugars.

In a paper "On the Influence of Variations of Temperature on the Deviation of Polarised Light by Solutions of Inverted Sugar, published in the CHEMICAL NEWS (vol. xxxix., pp. 212–234), I have given very fully the theory of the correction of the direct test of the optical saccharometer by a second test after inverting the cane-sugar. I will now re-state this theory, as on it depends the understanding of the correction obtained by Clerget's process.

If we have a sugar containing (1) cane-sugar, (2) inverted sugar, (3) other optically active bodies deviating to the right, (4) other optically active bodies deviating to the left, (5) optically inactive bodies, and if the direct test in the optical saccharometer gives a deviation D, we may

state that this deviation is the *resultant* due to the algebraic sum of all the deviations caused by the optically active bodies present.

Let us call C the deviation due to the cane-sugar in the mixture, I the deviation due to invert sugar, G the deviation due to the sum of dextro-rotate bodies in the mixture other than cane-sugar, and H the deviation due to laevo-rotate bodies other than inverted sugar, and we may state that—

$$(1) D = C - I + G - H.$$

The only known quantity in this equation is D; the quantity we want is C. It is to Clerget that we owe the solution of this problem. By heating the solution already tested directly with hydrochloric acid the cane-sugar is entirely converted into invert sugar. After inversion, the solution is again placed in the saccharometer, and a certain deviation is observed, which is corrected for the dilution with acid, and which thus corrected we will call D'. By the action of the acid the quantity C has disappeared, and has been replaced by a certain deviation —i, due to the inverted sugar resulting from the cane-sugar which previously gave C. Supposing that the quantities —I, G, and —H remain the same, we have—

$$(2) D' = -i - I + G - H.$$

If we now subtract equation (2) from equation (1) we have

$$D - D' = C + i.$$

In this equation the required quantity C is not entirely free, but we may find it if we know the deviation to the left which is afforded by the inversion of a solution of pure sugar giving ro to the right. Clerget found what this deviation is for every degree Centigrade, and he constructed a table by means of which we may know the value of C, when we know the value of D—D', which is equal to C+i.

If we have a solution of pure sugar, giving a deviation to the right equal to 100, the corresponding deviation to the left after inversion is expressed by $-(44 - \frac{1}{2}t)$, t being the Centigrade degree of the solution of inverted sugar at the time of observation. The required quantity C is given by—

$$\frac{C}{C+i} = \frac{100}{100 + (44 - \frac{1}{2}t)}$$

whence—

$$C = \frac{100(C+i)}{100 + (44 - \frac{1}{2}t)}$$

The quantity C+i is known, being equal to D—D'.

This is the logical base of Clerget's process. To demonstrate that the process is unreliable it must be shown that during inversion the quantities —I, G, and —H have suffered changes, and therefore the equation—

$$D'' = -i - I + G - H$$

is not correct.

There is a possible flaw in the assumption that the quantity —I+G—H remains the same after inversion. Although —I does not vary, we are not perfectly sure that G and —H remain unaltered. We know nothing of the bodies which, in a sample of sugar, give these quantities and their relative proportions. We must bear in mind, however, that the principal constituents of a *straight* sugar are cane and invert sugar. The other optically active bodies are present in small quantities, and the resultant of the changes produced in them must be very small, as any dextro-rotate increase, due to some of the active substances, is likely to be compensated by laevo-rotate increase due to others. It is possible that in syrups and other low products in which these disturbing bodies are present in larger quantities, an appreciable error may arise from the action of inversion on them. Dr. Tucker cites one thing to the point in this connection, on the excellent authority of Landolt. It is that, after inversion with hydrochloric acid, beet-sugar syrups contain optically active acids. The error resulting from this could be done away with by neutralising with carbonate of soda, as is generally done. According

to Dr. Tucker, when the bodies which accompany cane-sugar are optically inactive the correction is unnecessary. This is undoubtedly true, but to assume in a given sugar that they are so is to assume the very thing to be proved. Of course, if in equation (1) —I+G—H=0, D=C.

Dr. Tucker also says that the unreliability of Clerget's process is shown from his own experience and the published results of others, which show that the corrected percentage is often lower than the first reading. This is due to the fact that —I+G—H is a positive quantity. I have often found this to be the case, but I do not understand why the quantity —I+G—H must either be equal to 0 or be a negative quantity. If any experiments have established this important point they have not been published to my knowledge.

Dr. Tucker says that one author has recommended Clerget's process in sugars containing a large proportion of commercial grape sugar, "notwithstanding that this substance is dextro-rotate at all temperatures, and generally contains much dextrin and soluble starch, with a dextro-rotation about three times that of dextrose."

If we refer to the two formulae $D = C - I + G - H$ and $D' = -i - I + G - H$, we may see that however large may be the quantity G, by subtracting the second equation from the first we will have $D - D' = C + i$.

It would have been more to the point to show that starch glucose and accompanying impurities have their rotary power appreciably altered by heating with one-tenth of hydrochloric acid at 69° C. for a few minutes.—I am, &c.,

P. CASAMAJOR.

Brooklyn, March 13, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 12, March 20, 1882.

Double Decompositions of the Haloid Salts of Mercury.—M. Berthelot.—In presence of the hydracids, the acid which disengages most heat unites by preference with the oxide of mercury, independent of any consideration of supposed strength, or of solubility or insolubility. This reaction is total if there is no formation of secondary compounds, acid salts, acid hydrates, or double salts, these bodies being such that their heat of formation compensates the inequality of the heats of neutralisation. On the contrary, there is distribution when the heat of formation of the secondary compounds exceeds the difference of the heats of neutralisation. The relations are regulated on the same principles in presence of alkaline salts.

Use of Superphosphates upon the Calcareous Soils of South Eastern France.—M. de Gasparin.—The author gives partial analyses of the mineral phosphates of Tavel and Figeac, both much used in the manure trade. The former of these contains 31.5 per cent of iron, calculated as sesquioxide, and the latter 42.7. A sample of superphosphate made from such materials contained 29.7 per cent of insoluble matter, only 11.71 of phosphoric anhydride, 9.7 per cent ferric oxide, and 3.2 alumina in a soluble state.

New Compounds of Nitric Acid and Acetic Acid with Ammonia.—L. Tiouss.—In former papers (*Comptes Rendus*, lxxviii., pp. 578 and 1267, and xcii., p. 715), the author has described the compounds of dry ammonia with the hydracids. He now shows that it combines also in several proportions with the oxacids. The first of these compounds here described contains 5 equivalents ammoniacal

gas to 2 eqvls. of nitric acid. This ammoniacal nitrate is solid at temperatures below -22° . The formula of this body is $\text{NO}_2\text{HO}, \text{NH}_3 + 3\text{NH}_3$. In addition there seems to be another nitrate of the probable formula of—



The author has also obtained two acetates.

Observations on M. Violle's Recent Note on the Boiling-heat of Zinc.—L. Troost.—The author states that the results obtained by Sainte-Claire Deville and himself differed very little from those published by M. E. Becquerel.

Action of Acid Solutions upon Stannous Oxide.—A. Ditté.—Stannous hydrate may lose its water and become transformed into crystals of the anhydrous oxide under circumstances which are complex and imperfectly known. The crystallisation may occur either in acid or alkaline liquids. The author examines the first case in detail, and shows that with reference to oxide of tin the acids may be divided into two groups. Those of the one group give, with this oxide, salts which are entirely decomposed by boiling water, and determine its transformation into the crystalline oxide in consequence of successive reactions. These salts, decomposable by water, yield free acid, and behave absolutely like the acids themselves, determining the crystallisation of stannous oxide. The acids of the second class do not give rise to these successive reactions, and the hydrated stannous oxide never becomes anhydrous and crystalline under their influence.

Action of Ozone upon the Salts of Manganese.—M. Maquenne.—Ozone readily determines the transformation of manganous oxide into permanganic acid in conformity with thermic theory.

Clarification of Must destined for the Manufacture of Champagne.—F. Jean.—Not suitable for abstraction.

Nuts of Kola, Gourou, or Ombene.—E. Heckel and F. Schlagdenhauffen.—These nuts are the fruit of *Sterculia acuminata*, an African tree. They are richer in caffeine than the best coffee, not combined with an organic acid, but free. They also contain a very appreciable quantity of theobromine, besides grape-sugar, and starch. There is but little fatty matter.

Crystalline Forms of Zirconia, and the Conclusions to be drawn for its Qualitative Determination.—A. M. Levy and L. Bourgeois.—This paper requires the accompanying diagrams.

Moniteur Scientifique, Queneville.
January, 1882.

Diastase of Koji.—R. W. Atkinson.—From the *Proceedings of the Royal Society*.

Alkaloids having a Mydriatic Action.—A. Ladenburg.—The substance of this memoir has already appeared in the *CHEMICAL NEWS*.

Industrial Society of Mulhouse.—Meeting of Nov. 9, 1881.—Papers were read on the action of an alkaline solution of potassium ferricyanide upon aniline hydrochlorate, by M. Wagner; on the applications of tannin in dyeing and printing, by M. J. Kechlin; and on the manufacture of potassium sulphocyanides and ferrocyanide, by Uri de Gunzburg and J. Tscherniac.

Patents Concerning the Manufacture of Artificial Colouring-Matters.—Abridged specifications of fourteen patents.

Trichinae and their Distribution.—From the *Journal of Science*.

Composition of Elephant's Milk.—Dr. C. Doremus.—From the *Journal of Applied Science*.

The Last Discoveries of F. Selmi.—A. Vernon.—In a letter to M. G. Ercolani, the late Prof. Selmi speaks of a saccharifying agent contained in the white of egg. This is the more important as the yolk contains starch.

Risks of Fire in the Use of the Electric Light and on Preventive Measures.—Dr. H. Morton.—From the *Sanitary Engineer*.

Production of Manures in Distilleries.—L. Faucheux.—The author shows that much plant-food in the shape of potassium salts, ammoniacal and other nitrogenous matter, and phosphoric acid is often run to waste in the refuse of distilleries.

Commercial Aluminium Sulphate.—M. Debray.—From the *Journal de la Soc. d'Encouragement*.

Rice Paper.—From the *Journal of Applied Science*.

Analysis of Soaps.—C. Hope.—From the *CHEMICAL NEWS*.

Manufacture of Gas from Castor Oils.—From the *Journal of Gas Lighting*.

Purification of Ill-flavoured Alcohol.—M. Naudin.—The author proposes the use of hydrogenising agents.

Manufacture of Maltose.—M. Dubrunfaut.—The author considers the probable hearings of this new manufacture upon agriculture and upon beet-root sugar.

A New Alkaloid extracted from the Cinchona Bark.—D. Howard and J. Hodgkin.—From the *Journal of the Chemical Society*.

Determination of Aceton in Commercial Wood-Spirit.—M. Kramer.—Into a test-tube holding 50 c.c. are poured 10 c.c. of a binormal solution of soda to 1 c.c. of the sample under examination. There are then introduced 5 c.c. of a binormal solution of iodine, and the mixture is shaken. The precipitate of iodoform is dissolved in 10 c.c. of ether and 5 c.c. of the ethereal solution are evaporated in a tared watch-glass. The residue represents iodoform, which is calculated as aceton. Wood-spirit used in the manufacture of aniline colours should not contain more than 1 per cent of aceton.

Preparation of Aluminium.—Aluminium sulphide is obtained from powdered cryolite, and it is then decomposed by heating to redness with iron turnings. The cryolite is first dissolved in water, which dissolves out the sodium fluoride. The residue, aluminium fluoride, is calcined with calcium sulphide, the results being aluminium sulphide and calcium fluoride.

Justus Liebig's Annalen der Chemie,
Band 211, Heft 1.

Hypophosphoric Acid.—T. Salzer.—The author's former conjecture that hypophosphoric acid is identical with the ultimate product of the spontaneous oxidation of phosphorus is not confirmed. The hypophosphates and their solutions are permanent, though the free acid undergoes a gradual change on concentration with the formation of pyrophosphoric acid. The preparation of the acid and the properties of its salts are described at length. The determination of hypophosphoric acid is effected by titration with potassium permanganate. The operation is performed at a gentle boil; the sulphuric acid used for acidification must be free from nitrogen compounds, and from any impurity which might decompose permanganate; the titration must be begun at once after adding the sulphuric acid, and must be completed as quickly as possible. The addition of large quantities of water must be avoided unless freed from dissolved oxygen by boiling for at least an hour.

Origin and Constitution of β -Naphthoquinone and some of its Derivatives.—C. Liebermann and P. Jacobson.—The authors treat of the formation of β -naphthoquinone from β -naphthylamine; the preparation of β - and α -naphthoquinone by means of the azo-compounds; the constitution of β -naphthoquinone and of the anilides of the naphthoquinones.

Preparation of the Rubidium and Cæsium Compounds, and the Isolation of the Metals.—Dr. Car Setterberg.—Already noticed.

Suberon.—Dr. A. Spiegel.—The author gives an account of oxy-suberonic acid, chloro-suberonic acid, suberon, and suberan-carbonic acids.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 5, 1882.

Pezzers Accumulator.—This battery is constructed as follows:—Narrow bands of lead, 10 to 15 millimetres broad and 500 in length, are obtained by cutting up sheets of a suitable thickness, and they are made to take a waved form by being passed between the rollers of a machine used for folding stuffs obliquely. Each of them is doubled in two, and they are placed in juxtaposition, fold upon fold. The free ends are then soldered together by the autogenous process, forming them into fringes. These fringes are introduced in place of the carbon and the zinc in a Bunsen element (Ruhmkorff's model), where some of them fill the porous vessel, and the others the interval between the porous vessel and the sides of the exterior vessel. The soldered ends are upwards and the folds downwards. Plates soldered to the upper part serve as electrodes.

Journal de Pharmacie et de Chimie.
January, 1882.

Chemical and Physiological Researches on the Ordeal Poison of the Gabonese.—E. Heckel and F. Schlagdenhaufen.—The plant in question, *M'Boundou*, contains strychnine. No other alkaloid is present.

A Molecular Compound of Camphor and Aldehyd.—P. Cazeneuve.—Already noticed.

Mercury Salicylates.—H. Lajoux and A. Grandval.—The neutral mercuric salicylate is insoluble in water, ether, and alcohol, but soluble in solutions of common salt. The mercury is completely masked, and gives no reaction even with sulphuretted hydrogen. To show its presence in the moist way the salicylate must be heated gently with sulphuric acid till it becomes flesh coloured. It then dissolves, and the liquid becomes colourless. The mercury can then be detected in the liquid by the ordinary reagents. The author describes also a normal salt, which is less stable than the neutral salicylate, and also a neutral and a normal salicylate.

MEETINGS FOR THE WEEK

THURSDAY, 11th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 5.30.
— Photographic, 8.
WEDNESDAY, 12th.—Microscopical, 8.
FRIDAY, 14th.—Astronomical, 8.
— Quekett Microscopical Club, 8.

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ST. PAUL'S SCHOOL. An examination for filling up about six vacancies on the Foundation will be held on the 19th April, 1882. For information apply to Clerk to the Governors or to the School Secretary, St. Paul's Churchyard.

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ANALYSIS BY JOHN PATTINSON, ESQ.

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THE CHEMICAL NEWS.

VOL. XLV. No. 1168.

ON THE SPECTRUM OF CARBON.*

By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry, and
J. DEWAR, M.A., F.R.S., Jacksonian Professor,
University of Cambridge.

THE spectroscopic investigations we have communicated to the Society "On the Reversals of the Lines of Metallic Vapours" have shown the importance of a thorough and accurate knowledge of the ultra-violet spectra of the elements, for it is in the lines of short wave-length as a rule that the greatest emissive power is manifested, and they are therefore most readily reversed. Thus we have succeeded in reversing upwards of a hundred lines in the ultra-violet spectrum of iron (*Proc. Roy. Soc.*, vol. xxxii., p. 404). The necessity for accurate data in regard to this region of the spectrum led us to make a long study of the spectrum of magnesium, and the results of this investigation appeared in the volume of the *Proc. Roy. Soc.* just cited. Having had occasion to examine the origin of the different fluted spectra of carbon, it became apparent that a complete knowledge of the relations of these spectra to the simple spectrum of the element could only be reached by the help of a complete record of the line spectrum. Angström and Thalen, in their memoir "On the Spectra of the Metalloids" (*Nova Acta Reg. Soc. Upsal.*, Ser. 3, vol. ix.), give a map and table of wave-lengths of the lines due to carbon in the visible part of the spectrum, as distinguished from the fluted spectra given by compounds of carbon, namely, carbonic oxide, cyanogen, and acetylene. These lines, they state, always appeared when very powerful induction sparks were passed through the vapour of any compound of carbon, or between carbon electrodes. This line spectrum is remarkable for simplicity, consisting of eleven lines, of which the single line in the yellow, followed by a triple group in the green, and a very strong line in the blue, recall vividly the spectrum of magnesium; and as we know two modifications of the spectrum of magnesium which seem to be due respectively to the oxide and a hydride, the parallel between the behaviour of the two elements is the more striking. The plates of the ultra-violet spectra of the metals by the late Prof. W. A. Miller (*Phil. Trans.*, 1864) include plates of the spark taken between metallic electrodes in different compounds of carbon, which show with sufficient clearness that there are some five groups of lines in the ultra-violet spectrum of this element. In the observations here described we have preferred taking intense induction sparks between pure graphite poles in different gases.

A figure accompanying the paper represents the ultra-violet spectrum of carbon to a scale of wave-lengths within the range of the rays transmitted through calcite. The lines figured have been observed in photographs of the spark of a large induction coil, having a large Leyden jar in connection with the secondary coil, between poles of purified graphite in air, carbonic acid gas, hydrogen, and coal-gas. The same lines have been observed in photographs of the spark between iron, and between aluminium poles in carbonic acid gas. By comparing the photographs taken under these different circumstances, we have, we believe, eliminated the air lines, which are numerous and strong in the region between H and T, and will form the subject of a future communication, and also the metallic lines which graphite, purified with the utmost care, still exhibited.

The graphite was purified by being stirred in fine pow-

der into fused potash, and subsequent treatment with aqua regia, by prolonged ignition in a current of chlorine, and by treatment with hydrofluoric acid. The well-washed powder was afterwards compressed into blocks by hydraulic pressure between platinum plates, and from these blocks the electrodes employed were cut. Notwithstanding the purification the photographs of the spark between these electrodes still showed very distinctly lines of magnesium and iron. This fact shows the extreme difficulty of getting rid of all impurity, and the caution which is requisite in any reasoning depending on the assumption of chemical purity in the materials employed. It is very possible that the magnesium and even the iron in this case may have been due to oxides of those metals in the floating dust of the laboratory, which we know always contains sodium compounds, and which at Cambridge—where the water, soil, and bricks contain sensible quantities of lithium—almost always show traces of that element.

The wave-lengths of the strongest carbon lines were determined by means of a Rutherford diffraction grating having 17,296 lines to the inch. The measures were made in the following way:—The collimator and telescope of the goniometer were first centred by the instrument maker's marks. The telescope was then more carefully adjusted for centre by directing it on to a distant mark, taking the reading of the circle, turning the arm carrying the telescope through 180° and reversing the telescope, whereby the mark was again brought into the field of view, and adjustments were then made until the mark had the same position on the cross-wires in both positions of the telescope. The grating was next placed in position, and, after adjustment to the vertical plane, was brought very nearly at right angles to the axis of the collimator by turning it until the sodium D lines in the spectra of the second order were observed to fall at equal distances on either side of the collimator. The small photographic slide, containing the sensitive plate, fitted the telescope in place of the eye-piece, and so could easily be turned about an axis coincident, or nearly so, with the optic axis of the telescope. In taking a measurement of the position of a line the approximate wave-length was first found by interpolating between the nearest cadmium or other lines of known wave-length in photographs taken with calcite prisms. The telescope was then set to the angle corresponding to this approximate wave-length for the spectrum of the fourth order. The lower half of the slit was closed by a shutter, and the photographic slide having been adjusted for level, the plate was exposed to the light which came through the upper half of the slit, and gave an image of the lines in the lower half of the field. When this exposure was completed the photographic slide was turned round through 180° about the axis of the telescope, so as to bring to the top that part of the sensitive plate which had been before lowest. It was then exposed a second time, and thus two images of the same line were impressed on the plate, which were necessarily at equal distances on either side of the point where the axis of the telescope met the plate. By a subsequent measurement with a micrometer under a microscope of the distance between the two images, and the conversion of this distance into angular measure, a connection was found, which was added to or subtracted from the reading of the circle to get the exact deviation of the ray producing the line under observation. Another photograph of the same line was next taken in the same way as before, except that the telescope was placed at the corresponding angle on the other side of the collimator. From the two angles thus found the wave-length of the line was calculated. The process was repeated three or four times for each line, and the mean wave-length thus found for carbon lines were 2297.4, 2478.4, 2508.7, 2511.6, 2836.3, and 2837.3. The numbers deduced from the different photographs of the same line differed from one another in the last figure only, so that we are justified in assuming the first four figures to be accurate in each case. The wave-lengths of the remaining lines were obtained by interpolation from mea-

* Abstract of a Paper read before the Royal Society, March 9th, 1882.

In this clear liquid the dark cloud caused by the titrated solution of sodic sulphide is easily distinguished on the clean white surface of the porcelain dish. The operation takes only a few minutes. Other metals, whose sulphides agglomerate in heavy clots in the same way, can probably also be estimated by this process.

As chloride of silver agglomerates in curds by agitation in exactly the same way, the white cloud due to a fresh formation of this salt may very easily be observed over a black surface. A solution of sodic chloride, dropped into one of nitrate of silver, gives a very distinct white cloud, which is most distinctly seen if the precipitation takes place in a flat dish of black glass, or one of clear white glass, the under side of which has been covered with lamp-black. The best temperature for clearing up the solution by agitation is about 65° C. Chloride of silver, however, does not agglomerate so completely in an acid solution as the sulphides of lead and copper in the alkaline tartrate solution. In the slightly turbid liquid, as seen against the black background of the glass dish, we may, however, very easily distinguish the white cloud produced by the addition of a single drop of sodic chloride.

HOLLAND'S PROCESS FOR MELTING IRIDIUM.*

By W. L. DUDLEY.

This metal has been known to chemists for some years, although the public has had but little experience with it; even mining prospectors are, for the most part, unfamiliar with its appearance and properties.

In the year 1803 Smithson Tennant, while investigating the metallic residue which remained when platinum ores were dissolved in aqua regia, thought he had discovered a new metal. Descotils, Fourcroy, and Vauquelin were at the same time examining similar residues, and they also came to the conclusion that a peculiar metal was present; but, however, in 1804, Tennant announced to the scientific world that he had proved the presence of two new metals in these platinum residues, to one of which he gave the name of *iridium*, on account of the iridescence of some of its compounds; and to the other the name of *osmium*, because of the peculiar odour which its volatile oxide possessed.

Iridium is found in considerable quantities in the platinum ores; in the forms of platinumiridium, which is an alloy of platinum and iridium; and osmiridium or iridosmine, which is an alloy of osmium and iridium. The platinumiridium occurs in grains, and sometimes in small cubes with rounded edges. The iridosmine is usually found in the form of flat, irregular grains, and occasionally in hexagonal prisms.

The geographical distribution of this metal is quite wide; it is found in California, Oregon, Russia, East India, Borneo, South America, Canada, and Australia, and in small quantities in France, Germany, and Spain.

As we find iridosmine, or the so-called native iridium, it is associated with numerous rare metals, viz., osmium, platinum, rhodium, ruthenium, and palladium, and also with iron and copper.

Iridium possesses a white lustre resembling that of steel. In the cold it is quite brittle, but at a white-heat it is somewhat malleable. It is one of the heaviest of metals, having a specific gravity of 22.38. When an alcoholic solution of the sulphate of iridium is exposed to sunlight, it deposits an impalpable black powder, which has the very peculiar property of setting fire to a piece of paper saturated with alcohol when brought into contact with the slightest trace of it. When heated in the air to a red-heat the metal is oxidised, but on raising the temperature to

about 1000° C., it parts with its oxygen; hence, at a high heat (above 1000° C.) it is not oxidised. It is insoluble in acids, but is very slightly soluble in aqua regia when heated for many hours.

Iridium is one of the most difficultly fusible of all metals, as will be seen from the following partially successful attempts to fuse it: in Gmelin's "Handbook of Chemistry" (vol. vi.) we find the results of some of these experiments. "Vauquelin fused it in very small quantity only, on charcoal ignited in a stream of oxygen, and obtained a somewhat ductile globule." This could not have been pure iridium if the globule was ductile, as he states. "Children fused it by his galvanic battery into a white, strongly lustrous, brittle, and still somewhat porous globule, of specific gravity 18.68. This globule probably contained platinum (Berzelius). One grm. of iridium, heated upon charcoal before Döbler's oxy-hydrogen blowpipe, fuses into a bright globule, which, however, appears to absorb gas, since, on solidifying, it throws out excrescences, and cavities are formed in its interior."

Platinum, which melts at a much lower temperature than iridium, was first fused by Dr. Hare, of Philadelphia, the inventor of the oxy-hydrogen blowpipe. He succeeded in melting about 2 lbs. (977 grms.) at one time. He was also the first to melt iridium by this means.

As was before stated, the iridium which these old chemists claimed to have melted must have been impure, containing metals of lower melting-points, since one says he "obtained a somewhat ductile globule," and another found the specific gravity to be 18.68, when it is well known that pure iridium, in the cold, is not in the least ductile or malleable, and its specific gravity is 22.38. Alloys of platinum, with a small percentage of iridium, can be comparatively easily melted by the oxy-hydrogen blowpipe.

In a late determination, Vielle estimates the melting-point of pure iridium at 1950° C., and platinum at 1750° C.

A few years ago MM. Deville and Debray succeeded in modifying Dr. Hare's blowpipe to such an extent as to obtain more satisfactory results, and in 1870 they prepared bars for the International Metrical System Convention, of 10 per cent iridium and 90 per cent platinum, and they successfully melted, in one charge, over 400 lbs. of this alloy. This work was carried out under the superintendence of Mr. Geo. Matthey, of the firm of Johnson, Matthey, and Co., of London. This alloy is largely in use for making platinum dishes, stills, and crucibles, as the iridium renders the platinum much stiffer and harder, and consequently more durable than the pure metal.

This brief outline of the history of methods which have been employed for fusing iridium brings us to within a few months of the present time.

At this stage of the subject I have the pleasure of presenting to you the results of the labours of Mr. John Holland, the well-known gold pen manufacturer of our city. Mr. Holland being engaged in the manufacture of what are known as diamond-pointed pens (the points being in fact iridium), it was quite natural that he should be impressed with the desirability of discovering some means of better preparing the metal to meet his own wants in his branch of manufacture. About eighteen years ago he commenced his experiments to that end, and never ceased his efforts, sparing neither time nor money in his determined pursuit of the object. At last his labours have been crowned with complete success. He placed a small quantity of the metal in a Hessian crucible, and after raising it to a high heat he quickly added a stick of phosphorus, when, greatly to his delight, as soon as the fumes cleared away, he saw the liquid mass of metal in the bottom.

It was at this stage of the discovery that the author of this paper became acquainted with it. For certain purposes for which it was proposed to use the metal, it was found necessary to remove the phosphorus which it contained, and this was the first problem that demanded attention. After various experiments, it was found that

* From the "Scientific Proceedings of the Ohio Mechanics' Institute," January 1, 1882.

lime was best adapted to the purpose. The metal, after being melted and cast into suitable shape, is embedded in lime contained in a Hessian crucible, and subjected to a very high heat. This process is repeated several times, each time allowing the metal to remain in the furnace longer than before; when, after four or five such operations, the phosphorus is practically all removed, having combined with the lime. For the want of a better name, and since the metal is rendered much tougher, we have termed this the annealing or dephosphorising process. The removal of the phosphorus renders the metal slightly porous, but it is as refractory as the original.

Having our time entirely occupied in experimenting with an aim toward practical results, we were unable to do much scientific work; but we are indebted to Prof. F. W. Clarke, of the University of Cincinnati, for assistance in this line. Prof. Clarke has undertaken an analysis of the fused metal, and although his work is unfinished, he states that it contains about $7\frac{1}{2}$ per cent of phosphorus.* These analyses are accompanied by peculiar difficulties, since phosphorus is a new element for consideration in the analysis of platinum metals. This offers an interesting subject for research, which at some future time will be pursued.

On casting, we sometimes find the metal slightly porous. The polished surface, to the naked eye, may look perfectly homogeneous, but under the magnifying-glass minute holes may be seen.

In order to obtain the iridium in a convenient form for making pen points, the molten metal is poured upon an iron plate, when the workman immediately strikes it with a heavy iron, thereby flattening it out into a slab of about 1-32nd of an inch in thickness. This slab is broken into small pieces, which are then ground into the proper shape. The grinding is accomplished as follows:—A copper wheel, technically called a "lap," about 12 inches in diameter and $\frac{1}{4}$ inch in thickness, revolving at about 3000 revolutions per minute, is covered with fine emery or corundum mixed with oil. The emery embeds itself into the copper, forming a rough and sharp surface. When the object to be ground is too small to hold in the hand, it is soldered on a piece of brass, which, after the grinding, is dissolved in nitric acid, leaving the iridium free. One ounce of iridium yields from five to ten thousand pen points.

The iridium melted by this process is compact and crystalline; it is harder than the natural metal. Its tensile strength has not been determined as yet. The natural grains of iridosmine are sometimes laminated in structure and are liable to split in the direction of the lamination.

The operation of sawing the metal is accomplished by means of a copper disk, making about 5000 revolutions per minute, assisted by emery and water. When the metal is ground to a smooth surface by means of emery on a copper wheel, as described, it acquires a good polish, which may be increased by using "crocus powder" afterwards on a similar wheel.

Iridium which has been melted by Mr. Holland's process is nearly as hard as the ruby, which is next in hardness to the diamond. It cuts glass readily; the best files are ruined by attempting to file it. It has about the colour of steel. It is not attacked by acids, and does not tarnish. The best steel tools fail to make any impression upon it.

A metal with this wonderful combination of valuable properties, will undoubtedly find many uses to which it can be applied with great advantage; and, although we do not propose to mention all its applications, yet it may be of interest to state the result of our experiments with it, as applied to the electric light. Our first experiments were with the incandescent lamp, substituting iridium for

carbon, and using it in the open air. As far as the durability of the metal was concerned, the result seemed favourable; but it required such a large amount of electricity to accomplish the result, as probably to render this method of lighting somewhat expensive.

A short time ago, Mr. W. M. Thomas, of this city, called on Mr. Holland, requesting a piece of iridium to be used in connection with the arc light. Mr. Holland had a small piece prepared, which was substituted for the negative carbon of the lamp. The first experiment was tried for one-half hour, without any apparent effect on the metal. Since then more complete arrangements have been made, and the lamp containing the same piece of iridium has been in operation for over seventy hours without any appreciable loss of metal. The amount of electricity required to maintain it seems to be much less than for the ordinary lamp. The point of light is always in the same position, and, consequently, can be used in a reflector without the additional clock-work, which is employed to accomplish this result with the ordinary arc light. The light can be made very steady, since the lower carbon, which burns and crumbles away, is dispensed with. When the metal is used where it is subject to intense heat, the phosphorus is removed; but where hardness and non-corrosibility are required, the phosphorus does not offer any inconvenience.

NOTE ON THE PRECEDING PAPER.

By R. B. WARDER.

PROF. DUDLEY has shown that the phosphide of iridium is harder and more fusible than the native metal. It is probably more brittle. These facts remind us of the properties imparted to iron by the presence of phosphorus, carbon, and other non-metals. The physical properties of alloys, and the effect of small additions of non-metals, are subjects of the greatest importance, whether considered in their industrial or their scientific aspect. We need not look further than the discussion on steel rails by Dr. C. B. Dudley, and others (*Jour. Frank. Inst.*, 1881), to see that such investigations are still in their infancy, even in regard to iron.

The "dephosphorising process" for the fused iridium bears a striking analogy to the use of a "basic" lining in the Bessemer converter, for the removal of phosphorus; in the latter case, however, the steel is melted, and the ingots are consequently homogeneous, while the solid bars of iridium become porous when the phosphorus is removed by heating with lime.

Prof. Dudley states that fused iridium has lately been used for the points of ruling and drawing pens, stiles, contact points for telegraph keys, and to replace agate in the bearings of analytical balances; it may soon be used also in the place of watch jewels and for bearings of the magnetic compass.

Principle of a New Photographic Revolver.—J. Janssen.—It is known that the principle of the photographic revolver consists in the rotatory movement of a sensitive plate upon which are produced successively, by means of a mechanical arrangement, images of the different phases of a variable phenomenon. But in this instrument the sensitive plate is stopped whenever an image has to be taken, and it only moves again to permit a neighbouring region, not yet acted upon, to receive a new image. Under these conditions a certain number of photographs may be taken per second, as has been done by M. Marey in his study on the flight of birds, but it is not easy to exceed the number of ten images per second. The author has succeeded in taking photographs upon a plate in motion at the speed of 0.15 metre per second, and finds that there is no limit to the possible number of images to be obtained in a given time.—*Comptes Rendus*.

* Two phosphorus determinations, by Prof. Clarke, gave 7.52 per cent and 7.74 per cent. Mr. O. T. Joslin found 7.58 per cent of phosphorus in the same sample. Osmium was found in traces only in the fused iridium.

LONDON WATER SUPPLY.

By WILLIAM CROOKES, F.R.S.

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February 15th, 1882.

SIR,—During the past year we have laid before you a report monthly, on the general condition and chemical composition of daily samples of the water delivered to London by the seven Companies taking their supply from the Rivers Thames and Lee. In the present Report we have reviewed and tabulated the results of our investigations and analyses of the 2181 samples that we have examined. Of these samples, 312 were taken from the mains of the New River Company, 307 from the mains of the East London Company, 315 from the mains of the Chelsea Company, 309 from the mains of the West Middlesex Company, 313 from the mains of the Lambeth Company, 317 from the mains of the Grand Junction Company, and 308 from the mains of the Southwark and Vauxhall Company.

We desire to remind you of the position we occupy with respect to this inquiry. All Reports, issued up to the time we commenced our work, related to a single sample of each Company's water, taken on one day only in the course of the month. Any criticism in praise or blame of the water supplied by that Company during an entire month was founded on the results yielded by that single sample. The Directors of the Water Companies felt, and we agreed with them, that it was quite impossible to judge fairly the purity or otherwise of a month's supply by an odd sample taken at random in the manner adopted. This might prove to be unsatisfactory, whilst the water supplied during the rest of the month was good, or vice versa.

Under these circumstances we advised the Companies, that the right way to meet the difficulty was, in our judgment, by the examination of a daily sample. And we accepted the responsibility of the task on the understanding that every detail relating to the times when, and the places where, the samples were collected, the methods of analysis to be adopted, and the form of the publication of the results obtained, should be left unreservedly in our hands.

This was on all points readily agreed to. We believe that nothing has been left undone to secure results, trustworthy in themselves, and sufficiently numerous to warrant the conclusions we venture to lay before you.

One general result of importance deducible from these examinations has reference to the amount of organic matter contained in the water. Taking the organic carbon as a trustworthy index of this organic matter, it appears that, contrary to popular though not to scientific opinion, the amount of organic matter present in the water supplied to London is, as a rule, exceedingly small. It is true that the variations in proportion appear at first sight to be considerable; but where the absolute amount of the organic matter in the water is so minute, never exceeding the $\frac{1}{1000}$ th of a per cent, the variations from about one-fifth of this amount and upwards, become for the most part quite insignificant.

Further, by an examination of the tables certain broad facts are brought out very prominently.

A close parallelism is for the most part seen to exist between the amount of organic carbon as determined by the combustion process and the amount of oxygen required to oxidise the organic matter as determined by permanganate. Despite some irregularities, the two quan-

ties sink together as the summer comes on, and rise again towards winter. Moreover minor fluctuations in the two quantities are in very many cases closely alike, and this so generally as to suggest that, for practical purposes of water analysis, permanganate affords indirectly a trustworthy measure of the organic carbon present in a water.

The connection between the greater or less colour-tint of the waters and the organic carbon is not quite so obvious. Still the broad fluctuations corresponding to the fall in summer and rise in winter are well marked; and some of the more decided oscillations are likewise reproduced. The blue, were it unmarked by the brown, would probably be constant in all cases, being the natural colour of pure water.

As these results are difficult to see from a mere examination of tables, we have reproduced them in the form of curves.

We now proceed to consider the several details in order, commencing with the colour of the waters.

Colour.

In describing the colour of a water, we adopted in the first instance, in common with chemists generally, certain arbitrary degrees of tint-depth, such as bluish green 0, green 1, &c., yellowish green 1, &c., brown 1, &c. From February 21st we made use of our new colour-meter, with which we had been experimenting for some time previously. This apparatus gives exceedingly accurate results, and is, in our opinion, a great improvement on all previous means (so far as we know them) for obtaining a standard of colour. Its mode of use is briefly as follows:—

Two hollow wedges are filled, one with a brown and the other with a blue solution,* and these are made to slide across each other in front of a circular aperture in a sheet of metal. In this way any desired combination of brown and blue can be produced. Each prism is graduated along its length from 1 to 50, the figures representing millimetres in thickness of the solution at that particular part of the prism.

On a level just below the prisms is a two-foot tube containing the water under examination, and having in front of it a circular aperture of the same size as the one in front of the prisms.

The stand supporting the prisms and tube is placed horizontally in front of an equably lighted window. The observer, standing a little distance off, sees two luminous disks, the lower one illuminated by light which has passed through two feet of the water, and the upper one illuminated by light which has passed through the respective thicknesses of the brown and blue solutions.

By sliding the prisms sideways one way or the other, it is easy to imitate with great accuracy the depth and tint of the colour of the lower or water-disk. A metal pointer affixed over the centre of the upper disk shows on the prism scales the number of millimetres in thickness through which the light has passed to produce a colour corresponding to that of the water. The results are recorded in the following way—Brown: Blue. Thus 20:20 means that the colour of the water, seen through a two-foot tube, was represented by 20 millimetres of brown, and 20 millimetres of blue solution.

It will be observed that the brown tint, noticeable when the water is examined through a stratum of two feet, is more marked during the winter than the summer months. In the case of the New River Company, however, the period during which the brown tint prevails is of exceedingly short duration, the water supplied by this Company to their consumers presenting generally the blue tint characteristic of pure distilled water. Respecting the

* The solutions are made in the following way:—

Brown Solution.—Dissolve ferric chloride and cobalt chloride in distilled water in such proportion that one litre of the solution contains 0.7 gram of metallic iron, and 0.3 gram of metallic cobalt. A very slight excess of free hydrochloric acid must also be present.

Blue Solution.—Dissolve 50 grams of pure crystallised cupric sulphate in one litre of distilled water.

* Report presented to the Right Honourable the President of the Local Government Board, on the Composition and Quality of Daily Samples of Water supplied to London during the year 1881.

brown colouring-matter, however, we would observe : first, that in the water supplied to London, taking the period when the colour is at its maximum, the degree of brown is nothing like so great as is found during the entire year in the waters of the Welsh Lakes (with the characters of which we are well acquainted), and in water of a similar kind, such as that of Loch Katrine, frequently lauded as a pattern water; and, secondly, that there is not the slightest evidence to show that the brown tint, dependent as it is on the presence of a minute trace of peaty matter or of some body resembling it, renders the water either injurious to health or objectionable to taste.

Clearness.

The terms in which we express the clearness or turbidity of a water are arbitrary.

A large bulk of water is poured into a beaker and examined in a good light. Its condition is also observed in the two-foot tube. If a trace of suspended matter be noticeable, we record the water as "turbid." If on close scrutiny we are able to detect any suspended matter whatever, we call the water "very slightly turbid," and we record the water as "slightly turbid," when we consider it to come between those two extremes. Nevertheless, although the terms used are arbitrary, they are to the practised eye definite, and mark with considerable exactness degrees of clearness and turbidity.

Of the 312 samples supplied by the New River Company, 4 were recorded as "very slightly turbid" (two of these being in the month of February), and 308 as clear and bright.

Of the 307 samples supplied by the East London Company, 30 were recorded as "very slightly turbid," and 4 as slightly turbid. All the samples recorded as slightly turbid, and 15 of those recorded as "very slightly turbid," were found amongst the February and March samples.

Of the 315 samples supplied by the Chelsea Company, 13 were recorded as "very slightly turbid," and of these 6 occurred in February and March.

Of the 309 samples supplied by the West Middlesex Company, 4 were recorded as slightly turbid, and 11 as "very slightly turbid." Of these, the 4 slightly turbid samples, and 3 of those recorded as "very slightly turbid" occurred in the month of February.

Of the 313 samples supplied by the Lambeth Company, 5 were recorded as turbid, 15 as slightly turbid, and 25 as "very slightly turbid." Of these, the whole of the 5 turbid samples, 10 of those recorded as slightly turbid, and 9 as "very slightly turbid," occurred in February and March.

Of the 317 samples supplied by the Grand Junction Company, 4 were recorded as turbid, 15 as slightly turbid, and 19 as "very slightly turbid": three of the turbid, 11 of the slightly turbid, and 4 of the "very slightly turbid" samples occurred in February and March.

Of the 308 samples supplied by the Southwark and Vauxhall Company, 4 were recorded as turbid, 6 as slightly turbid, and 20 as "very slightly turbid": 3 of the turbid, 4 of the slightly turbid, and 7 of the "very slightly turbid" samples occurred in the month of February.

It will be seen that a very large proportion of the more or less turbid samples occurred in the months of February and March.

We do not hesitate to say that the water supplied to the Metropolis is, as a rule, efficiently filtered. That an occasional period will occur (such as in the February and March of the past year), when perfect filtration becomes a matter of the greatest possible difficulty, is inevitable. Notwithstanding, however, the exceptionally severe weather experienced in the course of that winter, when pipes were everywhere bursting, and the ground had to be laid open to repair the damage, the number of turbid samples collected were comparatively few, and the extent of turbidity very slight. The suspended matter is almost entirely of the nature of clay and sand, and on the worst days, when the water was recorded as "turbid," averaged considerably less than 1 grain per gallon.

Free Oxygen.

The free oxygen present has been estimated in every sample collected, by a modification of Schützenberger's process.

These estimations of free oxygen in the Thames and Lee have both a scientific and a practical interest. This is the first occasion on which a series of experiments of such extent has been conducted. And the practical truth they convey is, that the waters of the Thames and Lee are well aerated, and contain in solution very nearly the full quantity of free oxygen that it is possible for water to dissolve. This fact is one of great importance as an evidence of the absence of decomposing organic matter; in other words, of the absence either of putrescent or putrescible matter. The late Dr. Miller, of King's College, some years ago pointed out that one of the characteristics of a water charged with obnoxious organic matter was the absence of oxygen in solution; and, on the other hand, that the dissolved oxygen in water of good quality and freely exposed to the air was considerable.

Ammonia and Organic Matter.

The free and saline ammonia has been estimated in a daily sample.

The actual organic matter present has been estimated by determining the oxygen required to oxidise the organic matter, and by combustion. In estimating the oxygen required, we have adopted the method described in detail by one of our number in the *Journal of the Chemical Society* (vol. xxxv., p. 46, 1879); while in the combustion process we have followed the lines laid down by Frankland and Armstrong. The oxygen required to oxidise the organic matter has, since February, been estimated in 7 samples daily, viz., a sample from each Company's supply. The organic carbon and nitrogen have been estimated in one sample daily. We have also given the quantities of oxygen necessary to oxidise the organic matter in the same water.

Hardness.

The initial hardness has been estimated in a daily sample of the water.

We have but one remark to make respecting the mineral matter held in solution in the waters. It consists mainly of the carbonates of the alkaline earths, with a small quantity of sulphates, nitrates, and chlorides. No one suggests that these salts are detrimental to health; and we should be prepared to contend that they are actually useful to the animal economy, as one means of supplying constituents required for the organism.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

March 20, 1882.

MR. ROBERT R. TATLOCK, F.C.S., President, in the Chair.

MR. JOHN CLARK, Ph.D., F.C.S., F.I.C., read a paper on "*The Composition of some Fossil Eggs from the Peruvian Guano Deposits.*"

Some time ago Mr. J. H. M. Fallen very kindly forwarded to me a number of fossil eggs from the Peruvian Guano Deposits, and as I thought their composition might interest this Society, I resolved to lay before you the results of my analysis.

According to information received from Mr. Fallen, the eggs were found in deposit No. 3 on the principal island of the group called the Islands of "Lobos de Afuera," at depths varying from about 2 feet to about 25 feet from the

surface. They are of two sizes, as you will observe from the specimens which I produce, the large eggs being those of the Pelican (*Pelicanus tagus*), called on the Peruvian coast the Alcatraz, and the small eggs those of the Potoyuncu or *Puffinusa garnotii*. These eggs appear to differ materially in their composition, and I shall therefore treat of them separately.

Pelican's Egg.—The specimen of the Pelican's egg which I examined was about the size of a goose egg. The shell, of which only a small portion remained, was black in colour, and the interior, which was completely filled, consisted of two materials, corresponding respectively to the "white" and the yolk of the egg. The portion representing the white of the egg formed the bulk of the contents. It was yellowish white in colour, of a somewhat silky lustre, and translucent crystalline appearance. The part representing the yolk was black in colour, and of a somewhat resinous aspect, and formed a very small proportion of the contents. As the quantity of dark-coloured matter in one egg was too small for a proper analysis, I picked out the dark-coloured portions from several eggs, and separated the white as completely as possible.

Potoyuncu's Egg.—The interior of the small egg was almost entirely filled with crystals of a somewhat pearly lustre, and contained very little of the black matter corresponding to the yolk.

Analysis of Pelican's Egg.

White Portion.

| | Per cent. |
|--------------------------------|-----------|
| Potassium sulphate | 34.48 |
| Sodium | 10.45 |
| Ammonium | 8.70 |
| " oxalate | 31.07 |
| " chloride | 1.12 |
| " phosphate | 2.21 |
| Free acid | trace |
| Soluble organic matter | 2.74 |
| Insoluble | 0.93 |
| Calcium phosphate | 1.58 |
| Silica | 0.02 |
| Water | 6.70 |
| | 100.00 |
| Nitrogen | 9.62 |

Black Portion from Several Eggs.

| | |
|---|--------|
| Soluble in H ₂ O— | |
| Potassium sulphate | 2.70 |
| Sodium | 0.95 |
| Ammonium | 1.58 |
| " oxalate | 4.95 |
| " chloride | 7.08 |
| " phosphate | 5.86 |
| Free acid | trace |
| Soluble organic matter | 23.15 |
| Insoluble in H ₂ O— | |
| Organic matter insoluble in water and ether | 16.30 |
| Fatty matter soluble in ether | 27.20 |
| Calcium phosphate | 3.93 |
| Water | 6.30 |
| | 100.00 |
| Nitrogen | 9.01 |

Analysis of Shell.

| | |
|--|--------|
| Phosphate of lime | 70.33 |
| Oxalate of lime | none |
| Carbonate of lime, alkaline salts, &c. | 29.67 |
| | 100.00 |

Analysis of Potoyuncu's Egg.

White Portion.

| | |
|-------------------------------------|--------|
| Potassium sulphate | 65.95 |
| Sodium | 17.98 |
| Ammonium | 10.70 |
| " oxalate | none |
| " phosphate | 1.74 |
| " chloride | 0.85 |
| Free acid | trace |
| Soluble organic matter, &c. | 0.40 |
| Insoluble organic matter | 0.83 |
| Calcium phosphate | 0.56 |
| Silica | 0.15 |
| Water | 0.84 |
| | 100.00 |
| Nitrogen | 2.95 |

When we compare these analyses, the most striking point of difference is the ammonium oxalate, which is present in the large egg to the extent of 31 per cent and absent in the small one.

I am not aware of the exact depth at which the specimens analysed were found, but I am inclined to think that the small egg came from a greater depth than the large one, and judging from the results obtained by Rose and Raimardi, I am of opinion that the proportion of oxalate of ammonium decreases with the depth. The question also very naturally arises, What is the origin of the substances found in the interior of the eggs? The large amount of potash which they contain renders it impossible that the salt can have resulted wholly from an alteration of the original contents of the egg, and they must be derived in part at least from infiltration, which probably takes place by a species of endosmosis. We know at any rate from the investigations of Chevreul that oxalate of ammonium and potash salts are normal constituents of Peruvian guano, and according to Shepherd there is a mineral, which he has called guanipite, found in rounded masses and veins in the Peruvian deposits, which consists of sulphate of potassium, sulphate of ammonium, and a small quantity of oxalate of ammonium; so that we have no difficulty in tracing the source of at least a great portion of the constituents of these eggs to the guano itself.

Mr. T. N. WHITELAW read a paper on the "Action of Ammonia on Fats at a High Temperature."

In the ordinary way of conducting the hard soap manufacture, a considerable amount of glycerin will remain mixed with the soap after the first running of spent lye, and from the great bulk of the soap a second washing, while giving a dilute glycerin with a relatively large quantity of salt, will still leave glycerin far from perfectly removed. Again, in the soft-soap manufacture the glycerin is left in the soap, where it probably serves no useful purpose, as a good soft soap can be made free from glycerin.

Considering such points it appears desirable to find some process by which the glycerin may be removed from the fats before beginning the soap manufacture. The decomposition of the fats by ammonia seemed a possible method of obtaining glycerin readily in a pure state, and the following experiments were undertaken to see if the fats, after treatment with ammonia at a high temperature, were in a condition suited for the manufacture of soap.

One part of cotton-seed oil was heated in a sealed tube with rather more than an equal volume of strong aqueous ammonia. After continued heating to 100° C., no distinct decomposition seemed to take place, but after twenty-four hours, with repeated agitation, the bulk of the oil came to the surface apparently unaltered. Even up to 110° C. there was no marked effect, but from 110° to 120° the oil became decomposed with comparative rapidity, and a clear amber-coloured thick liquid took the place of the previously-turbid mixture of oil and ammonia, indicating clearly that decomposition was complete. When

cold this appeared as a soft, yellowish white, opaque, soap-like mass. On heating for two or three hours in the water-bath, the ammonia was driven off, and an oily substance left, with a distinct sweet taste, which on washing yielded glycerin. The washed oil was heated with water, and weak caustic soda solution added, drop by drop, when combination took place, and a soap-like body formed, but in presence of a very slight excess of caustic soda the soapy compound was rendered insoluble, and coagulated into a tough mass.

A similar insolubility was observed in presence of a trace of common salt or carbonate of soda. This at once showed that the oil was different from ordinary fatty acids, of which the soaps are more soluble in dilute caustic soda or salt solutions than in water. On adding considerable excess of caustic soda and boiling, no change took place until the solution became concentrated, when evolution of ammonia occurred, becoming copious on fusion. By this process, although the glycerin is readily obtained, the oil is darkened in colour, and so modified as to be unsuited for soap making; and the operation of driving the ammonia off by fusion with caustic soda seems difficult and impracticable.

The change in the oil seemed to be due to the formation in some quantity of amides of the fatty acids, similar to those first examined by Bouillay in 1843, and further experiments were undertaken to find if this were really the case. The previous production of those amides was by digestion of the oils for some months with aqueous or alcoholic ammonia, and Carlet had only with the solid fats used the temperature of the water or salt-water bath, in which case he took from fifteen to twenty days to get complete decomposition.

In my experiments, "tallow cake," "palm oil," "cotton-seed oil," "rosin," and "crude palmitic acid" were heated to 120° C., as previously described, with 1 to 1½ volumes of aqueous ammonia, and in each case within from three to six hours a distinct change from turbid mixture to clear soap-like solution, indicated the completion of the reaction.

In the cases of almond oil and cotton-seed oil, where the ammonia was perhaps more distinctly in excess, after four to five hours heating a separation into two layers seemed to indicate undecomposed oil, but on closer examination both layers were found to be quite clear and soap-like, the separation being due probably to the insolubility of the amide in aqueous ammonia. On cooling, the ammonia (of which the greater portion seemed to be combined with fatty acids as ammonia soap) was neutralised with weak hydrochloric acid, and the oil obtained clear by boiling, washed, and dissolved in alcohol.

In the case of tallow cake, the melting-point of the modified oil was 28° C. higher than that of the corresponding fatty acids obtained by saponification of the tallow cake with soda and decomposing with acid. The solutions of the oils from "tallow cake," "palm oil," and "cotton-seed oil" on cooling, deposited white crystalline nodules, which, when purified by several crystallisations from alcohol, had the following melting-points (taken in a capillary tube suspended with thermometer in water, which was gently heated):—

| | | |
|-------------------------------|---------|--------------------------|
| Tallow, stearamide | 101° C. | } Probably still impure. |
| Palm oil, palmitamide | 96 | |
| Cotton-seed oil, ? | 98 | |

Being sufficiently near to Carlet's melting-points of 107° for stearamide and 101° for palmitamide if allowance is made for the different methods employed in taking them. The properties of those bodies correspond with the amides described by Bouillay, 1843, Bowney, 1855, and Carlet, 1859. Insoluble in water, soluble easily in hot alcohol, crystallising from it in white nodules, not decomposed by boiling solution of caustic soda, but decomposed by fused caustic soda with evolution of ammonia.

The solution of modified almond oil in hot alcohol did not give any crystals, though other indications of the

presence of an amide were given; and I have failed to get any body corresponding to oleamide.

The palmitic acid heat-d with ammonia seemed to yield simply "ammonia palmitate," as palmitic acid was recovered from it unchanged. Rosin was darkened in colour and modified in odour, but did not seem to be otherwise altered in properties.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, April 3, 1882.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair

Benjamin Baker, M.I.C.E., and William Edmund Rich, M.I.C.E., were elected members of the Royal Institution.

The Presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

Candidates for Membership were proposed for election.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 14, April 3, 1882.

Haloid Salts of Silver and Potassium.—M. Berthelot.—In this memoir the author continues his thermochemical studies on the double iodides, bromides, and chlorides. He concludes that the displacement of hydrochloric acid, when combined with silver oxide, by hydrobromic and hydriodic acids, free or combined with alkalies, is effected easily and in a preponderating manner by reason of the thermic preponderance of the two latter acids.

Combination of Free Hydrogen with Ethylene.—M. Berthelot.—The author has formerly shown (*Annales de Chimie et de Physique*) that free hydrogen combines with ethylene at a dark red heat, but only to a small extent. By operating at a lower temperature, and for a longer time, the author has succeeded in pushing the combination up to 70 per cent. Secondary products were almost entirely absent.

Specific Heat of Hyponitric Gas.—MM. Berthelot and Ogier.—The authors made measured the entire heat given up by this gas between 200° and 26° and between 100° and 26°. They deduce for the mean molecular specific heat (referred to the weight 46 grms.) between 100° and 200° the value +17.4, which is higher than the sum of the specific heats of oxygen and nitrogen. The specific heat of hyponitric gas, contrary to what is the case with the gases previously studied, is much greater between 100° and 26° than between 200° and 100°.

Researches on the Passage of Electricity through Rarefied Air.—E. Edlund.—The author concludes from his experiments that neither highly rarefied gases nor a vacuum can be an insulator.

Solar Apparatus.—A. Crova.—Under this name the author understands arrangements for obtaining mechanical power from the sun's rays. He considers that, except in very dry and hot climates, these devices cannot be practically applicable.

Heat due to Magnetisation.—M. Pilleux.—The author has heated to above 200° the iron core of an electro-magnet by causing it to be traversed by the alternate currents of a Mériten's machine. On substituting for the iron cores of non-magnetisable metals of different degrees of

conductibility the heating was not produced. On operating with iron of different degrees of temper, and even with steel, he finds that the coercive force of the cores increases the heating when they undergo the action of frequent magnetisations and demagnetisations. It is therefore to the magnetisation and not to induction currents that the considerable heating of electro-magnets in certain cases must be attributed. The coercive force plays the same part as the resistance to the passage of electricity when a wire is heated by the current of a battery.

Absorption Spectrum of Pernitric Acid.—J. Chapuis.—Pernitric acid cannot be prepared free from ozone. Fortunately, the bands of pernitric acid are more intense and their character is very distinct. Traces of this body show two lines between D and A, in a region where ozone presents no bands. Moreover, the rays are fine and black, in place of the broad grey bands with indistinct outlines, which characterise ozone. The author describes 8 rays, of which Nos. 1 and 4 are the blackest, most definite, and most characteristic. No. 3 is grey, and does not seem to separate itself from No. 4. Nos. 6 and 7 are superimposed on band 2 of ozone. Band 8 is superimposed on the two rays D. Nos. 2 and 5 are very fine.

Electrolysis of Distilled Water.—D. Tommasi.—The author proves experimentally that, contrary to the statements of several physicists, and especially of M. Bourgoign, pure water is capable of electrolysis, even by the current of a very weak battery, provided that the calories liberated by such battery are at least equal to the calories absorbed by the water on decomposition into its elements.

Determination of Nitric and Nitrous Acids as Ammonia.—A. Guyard.—The author's method is based on the fact that in presence of marsh-gas and soda-lime at a red heat the nitrogen oxides, whether free or combined with alkalis or the nitric oxides of organic matters, are totally converted into ammonia. The manipulations are identical in all points with those required by the processes of Peligot, Will, and Varentrapp. The author mixes intimately 5 grms. sodium acetate previously dried and 45 grms. of soda lime. Of this mixture 10 to 15 grms. are introduced at the bottom of the combustion-tube; this portion is intended to sweep out the ammoniacal gas by means of a current of marsh-gas. With the 35 to 40 grms. of the mixture remaining there is mixed 0.4 to 0.5 gm. of the nitrous compound. The whole is introduced into the tube, which is then filled up with ordinary soda lime, and the combustion is carried out as in an ordinary determination of ammonia. This process gives the whole of the nitrogen existing in different forms as ammonia. To determine in a sample the nitrogen in its three principal forms, three determinations are needed:—1. Determination of ammoniacal nitrogen with soda lime and calcium oxalate. 2. Determination of total nitrogen by the process above described; the difference gives the nitrogen present in nitric acid. 3. Determination of total nitrogen in a portion of the sample previously freed from nitrous acid by evaporation in the water-bath with an excess of acetic acid. The difference between No. 1 and No. 3 shows the nitrogen present as nitrous acid.

Effects of Compression upon the Hardness of Steel.—M. Lan.—Compression produces upon cast-iron and steel the same physical and chemical effects as sudden refrigeration.

Composition of Hydrated Carbonic Acid.—S. Wroblewski.—At the temperature of zero, and under a pressure of 16 atmospheres, hydrated carbonic acid is composed of 1 equiv. of carbonic acid (carbon dioxide) and 8 eqv. of water.

Ammonium Bisulphide and Cyan-hydrate.—M. Isambert.—Hydro-sulphuric acid and ammoniacal gas exert the same pressure in a mixture, whether they are free or combined, the pressure of each gas being inversely as that of the other. As regards the ammonium hydrocyanide, the tensions of hydro-cyanic acid and of ammo-

nium hydro-cyanide increase regularly with temperature. The tensions of the hydro-cyanide in presence of an excess of free hydro-cyanic acid are the same as those of hydro-cyanic acid alone.

Action of Sulphuretted Hydrogen upon the Saline Solutions of Nickel and the Metals of the Same Group.—M. Baubigny.—Not merely nickel and cobalt, like zinc, may be completely precipitated from the solutions of their chlorides and sulphates, but even iron is partially thrown down. Among the metals capable of yielding an insoluble sulphide, the only one which is not thrown down by sulphuretted hydrogen from the solutions of its chloride and sulphate is zinc. Its acetate, like those of cobalt, nickel, and iron, gives a precipitate of sulphide. The discrepancies in the statements of different authorities are due to variations in the conditions of the experiment; in the degree of dilution of the liquid, of the neutral salt and water; the nature of the acid of the salt; the relation of the weight of the acid and the base and of the free acid and the water; the temperature; the duration of the operation, and other conditions. The two following experiments are noted:—(1) To 0.2284 gm. neutral nickel acetate were added 0.29 grms. of monohydrated acetic acid, or 60 times the weight of the acid in the salt. (2) To 1.256 gm. of the same acetate were added 17.03 grms. monohydrated acetic acid, or 20 times the weight of the salt. The liquid in each flask was made up with water to 140 c.c.; it was saturated with sulphuretted hydrogen at 0°, and the flasks were then sealed and left at the temperature of the atmosphere, +12°–16°. In flask No. 1 there appeared no precipitate after the lapse of twenty-four hours, whilst in No. 2, containing the greatest weight of free acid for the same weight of water, the precipitate was distinct in an hour, and went on increasing. The liquid, which was green at first, had become colourless at the end of twenty-four hours. Only 0.0115 gm. of the nickel sulphate had escaped precipitation.

Ammoniacal Zinc Chlorides.—G. André.—A thermochimical study. The author gives the quantities of heat liberated in the formation of these compounds.

Hydrate of Hydrogen Sulphide.—M. de Forcrand.—The composition of this hydrate is given approximately as $\text{HS} + 15\text{H}_2\text{O}$. It is more stable than many similar compounds.

Synthesis of Quinine.—E. J. Maumené.—The discovery of H_2N has given the author the means of effecting this synthesis. He will shortly communicate to the Academy the details of the very simple operation in which H_2N yields very pure quinine sulphate. He is about submitting his product to therapeutic studies.

Action of Fuming Nitric Acid and Hydrochloric Acid upon Pilocarpine.—P. Chastaing.—Pilocarpine is easily converted into jaborandine by the action of excess of fuming nitric acid, and in small quantities by the action of hydrochloric acid in presence of oxygen.

Gastric Microzymas and Pepsine: Remarks on M. Gautier's Note of March 6th.—A. Béchamp.—The author calls in question the nature of the particles observed by M. Gautier.

Existence of Products Analogous to the Ptomaines in the Gastric and Pancreatic Digestions of various Albumenoid Matters.—J. Béchamp.—The author shows that several albumenoid matters possess certain properties of the ptomaines. In the normal processes of digestion there are formed substances possessing similar characters,—notably that of reducing potassium ferricyanide—and approaching closely to the poisonous alkaloids in their chemical reactions.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., January, 1882.

History of the Discovery of the Speaking Telephone of M. Graham Bell.—M. le Comte du Moncel.—It is

demonstrated that Mr. Bell first made the telephone speak by applying to it continuous and undulatory currents, a function of the vibrations of the voice, and solved the problem whether with the induced currents resulting from the vibrations themselves of the transmitter, or by the variations of the resistance of an imperfect conductor placed in connection with a voltaic circuit and themselves resulting from the vibratory effects. A fact curious enough to be reproduced here is that, in 1865, Mr. Yeates, of Dublin, in endeavouring to improve the telephone of Reiss, realised to some extent the liquid transmitter of Bell and Gray, for he introduced between the platinum contacts of Reiss's apparatus, a drop of water, which rendered it fit for the reproduction of articulate sounds.

Universal National Exhibition of 1878.—Colouring Matters and Colours.—M. Lauth.—This summary would have been very valuable if published two or three years ago.

Journal de Pharmacie et de Chimie.
February, 1882.

Action of Monohydrated Nitric Acid upon Morphine: Production of Picric Acid.—P. Chastaing.—This production of picric acid shows that the definition of the alkaloids given by Kœnigs—organic vegetable bases which are pyridic derivatives—is too absolute, and proves the existence in morphine of an aromatic nucleus, though there is room to believe that a pyridic nucleus may exist along with the aromatic nucleus.

Certain Critical Observations on the Volumetric Determination of Phosphoric Acid by means of Uranium Solution.—G. Guérin.—This method, first proposed by Neubauer for the determination of phosphoric acid in urine and favourably received at first by most chemists, has not yet taken rank among exact scientific methods on account of the irregular results obtained in attempting to generalise its use. Neubauer remarked very judiciously that sodium acetate retards the action of potassium upon the uranium liquid, and hence he recommends that all the determinations should be executed under the same conditions as the preparation of the standard solution. But sodium acetate is not alone in producing this effect; almost all ammoniacal salts have a similar action, and ammonium acetate in a moderately concentrated solution completely prevents the precipitation of uranium ferrocyanide. Hence follows the impossibility of obtaining by this method an exact volumetric determination of the phosphoric acid contained in urines which have undergone the ammoniacal fermentation. It is the same with phosphoric acid, isolated as authors recommend, as ammonium magnesium phosphate, and redissolved in acetic acid. On the other hand, certain chemists have found that the titration of phosphorites by this method gives results too low, and explain this fact by the entanglement of a little calcium phosphate by the uranium phosphate precipitated. Hence the precaution in such cases of fixing the standard of the solution, not by sodium, but calcium phosphate. Hence we consider Neubauer's method as little adapted for the direct determination of the phosphoric acid in urines, where it exists in the state of various phosphates. We believe that its use requires in a general manner that the value of the uranium solution should be determined by means of the same kind of salt to be determined, the presence of ammonium acetate being absolutely avoided.

Presence of Phosphorus and Iodine in Cod Liver Oils.—P. Carles.—When these oils are neutral and well filtered, iodine and phosphorus are absent. When the oils are acid these bodies are found, according to the degree of acidity, in milligrammes and tenths of milligrammes.

Determination of Alkaloids in Cinchona Barks.—M. Flückiger.—The author boils 20 grms. of the bark, finely powdered, with 80 grms. of water. To the cold decoction is added a milk of lime consisting of 5 grms.

lime and 50 grms. water. The mixture is evaporated in the water-bath until it is converted by constant stirring into little clots. With this mixture he fills a continuous exhaustion apparatus, consisting of a tube of glass 21 centimetres in length, 16 of which are filled up with the mixture, which rests upon a disk of brass pierced with little holes, and covered with a circular piece of filter-paper. This exhaustion apparatus is secured to a small flask containing ether, and heated in a water-bath at a constant temperature. The complete exhaustion of the mixture of bark and lime is ascertained by collecting a few drops of ether coming from the percolator, and adding to them an equal volume of a solution of 332 milligrams. potassium iodide and 434 milligrams. mercuric iodide in 100 grms. water. The solution ought not to become turbid. At the end of the operation the flask which contains the quinine dissolved in ether receives 36 c.c. of a decinormal solution of hydrochloric acid (3.65 grms. HCl per litre). The ether is distilled, and hydrochloric acid is again added until the solution becomes acid. It is then filtered, and the cold liquid is added 40 c.c. of a decinormal soda solution (4 grms. caustic soda per litre). The supernatant liquid is allowed to stand till it becomes clear, and there is then added to it soda-lye at specific gravity 1.3 till no further precipitate is produced. The precipitate is washed upon the filter with cold water until the washings no longer cause any turbidity in a clear solution of quinine sulphate saturated in the cold. The precipitate is pressed between leaves of filter-paper, and dried in the air. It is then detached from the paper, dried on a watch-glass over sulphuric acid, and lastly in the water-bath at 100°. The product should be at least 600 milligrams, if the bark contains 3 per cent. of alkaloids. But this precipitate is not pure quinine. To estimate the proportion of other alkaloids the quinine obtained is boiled in thirty times its weight of water for an hour and filtered. On cooling quinine hydrate is deposited. To 5 parts of the decanted liquid there is added 1 part of chlorine water and a drop of ammonia. If it is quinine a fine green colour will be produced. The dry alkaloid is soluble in twenty times its weight of ether if it is pure quinine.

Moniteur Scientifique, Queneville.
March, 1882.

Cotarnine.—E. von Gerichten.

Codeine.—Same author.

Morphine.—MM. von Gerichten and Schrötter.

Trimethylenic Alcohol and Trimethylene.—August Freund.—These four papers are translations from *Liebig's Annalen* and from the *Berichte der Deutschen Chem. Gesellschaft*.

Preparation of Compounds of Cæsium and Rubidium.—Dr. Karl Setterberg.—Already noticed.

"Disinfection" of Alcohols of Bad Flavour.—L. Naudin.—Already noticed.

Industrial Society of Mulhouse.—Meeting of Feb. 8th.—M.M. Schæffer and Dollfus reported on their examination of the decolourised blood albumen of Hofmeyer and Co. It dissolves in water without residue, and it becomes slightly coloured on steaming; more than egg-albumen though less than the ordinary blood-albumen. M. Schæffer reported that jute bleached on the principle of Cross and Bevan is much less darkened by steaming than that done by the old process.

Chloroform as an Anæsthetic.—M. Yvon.

New Method of Purifying Chloroform.—M. Yvon.

Observations on Chloroform intended for Anæsthetic Purposes.—M. Regnaud.—These papers are taken from the *Journal de Pharmacie et Chemie*.

Applications of Tannin.—Justs Kœchlin.—Reserved for insertion at length.

Fixation of Alumina as a Discharge on Indigo-Blue by means of Aluminium Chloride.—G. Saget.—Reserved for insertion at length.

Researches on Atropine.—Dr. L. Pesci.—From the *Gazzetta Chimica Italiana*.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 1, January and February, 1882.

This issue contains no original chemical matter.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 9, 1882.

Stability of Cupric Hydrate.—D. Tommasi.—The author gives his results in a tabular form. A solution of manganese sulphate at 0.30 per cent prevents cupric hydrate from losing its water, even if heated to 100°.

Medical Electricity.—This paper cannot be intelligibly reproduced without the five accompanying illustrations.

Illumination of Conservatories by the Electric Light.—The naked rays of the electric light were found injurious; after passing through glass globes they ceased to have any hurtful action upon plants, but their efficacy was not great. Nocturnal illumination is not fatal to plants, but there is no proof that it is beneficial. Upon the whole the results obtained at the Palace of Industry are not favourable.

No. 10, 1882.

A Summary of the Procedures for Preventing the Oxidation of Iron and Steel.—An account of the arrangements of a company formed for utilising the inventions of Barff and Bower, the ultimate credit of which is ascribed to Lavoisier.

The Arrangement of a Manganese Battery the Salts of which are Regenerated.—J. Rousse.—The battery in question is a Bunsen, in which the zinc is replaced by ferromanganese, containing 85 per cent of manganese. M. Rousse also proposes a nickel battery in contact with sulphuric acid or ammonium sulphate. He also uses, instead of the zinc in a Bunsen battery, an alloy of zinc and antimony, known as Crookes's alloy.

No. 12, 1882.

Extraction of Zinc by Electricity.—An account of the Létrange process applied to blende.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 2.

Changes and Effects of Water in Irrigation.—J. König and C. Krauch.—This memoir gives a comparison of the systems of Petterssen, Abel, and Vincent, and the common superficial system. As regards the manual action of the water, the absorptive power of the soil is less important than the precipitation of suspended particles, and the direct reception of the dissolved nutritive matter by the plants. The only plant-food retained by the soil itself is potash. The water employed does not seem to have been sewage.

Composition and Use of Falasco.—Prof. F. Sestini.—Falasco is a mixture of swam-plants, used in Italy as manure.

Manurial Experiments on Barren Heath-Soils.—Prof. A. Meyer.—The cost of manuring was in no case compensated by the increased yield. Plots left unmanured and those which received only potassium chloride yielded substantially nothing. After bone-dust the harvest was little better. The addition of peat-earth and of green manures gave the best result.

Presence of Phosphoric Acid in the Urine of the Herbivora.—Dr. de Leeuw.—The channel through which phosphoric acid is excreted depends on its relative proportion to the lime in the food.

Digestibility of Certain Foreign Oil Cakes.—E. v. Wolf.—The author assigns the first rank to earth-nut cake (*Arachis hypogaea*); then follow cotton-seed, sesame, and sunflower seed cakes. Cocoa-nut cake approaches more to palm oil cake.

Influence of Space upon the Development and the Yield of Crops.—Prof. E. Wollny.—A very extensive memoir, from which it appears that the quality of grain is best when the plants stand sparsely. In root-crops the roots or tubers are within certain limits larger, the larger the space allotted to each plant. The production of plants in general increases with the size of the space, that is, the seed reproduces itself in a higher ratio. Want of room deprives plants of a sufficiency of light, heat, and moisture, and promotes the action of parasites.

Milk and its Analysis.—In determining the moisture in milk, Marmann proposes to place it upon cotton-wool in a chloride of calcium tube and draw warm air over it. The moisture is expelled in ten to fifteen minutes, and the fat may be extracted from the dry residue by means of benzol. The cotton-wool must have been previously freed from grease.

Bulletin de la Société Chimique de Paris.
Tome 37, No. 5, 1882.

Chromic Acid and the Chromates.—Maurice Prudhomme and F. Binder.—The authors give two formulae to represent the double decomposition between potassium bichromate and the salts of the diatomic metals. In case of the salts of barium there are formed neutral barium chromate, potassium chloride, and free chromic acid, which is easily detected by means of barium peroxide and ether. The solution of chromic acid in addition to potassium chloride can contain merely barium chloride or potassium bichromate, but after a time it deposits a small quantity of neutral barium chromate, previously held in solution. In Warington's process for preparing chromic acid by means of potassium bichromate and sulphuric acid, an excess of barium bichromate is added to eliminate the excess of sulphuric acid and potassium bisulphate. But this body is possibly produced by the action of chromic acid upon the neutral chromate, but not by double decomposition, and the process of purification seems open to criticism. This method of preparation is a new proof in support of the constitution of potassium bichromate, which may be considered as a molecular compound of neutral chromate and chromic acid easily displaceable.

Action of Time upon Ferric Hydrate.—D. Tommasi and G. Pellizzari.—Already noticed.

Stability of Cupric Hydrate.—D. Tommasi.

A New Class of Borotungstates.—D. Klein.—The author has obtained and analysed the boro quatuordecitungstates of sodium (disodic), barium, potassium, silver, as also certain double salts.

Quinoleine derived from Cinchonine.—Göschner de Coninck.—The quinoleine obtained has a pleasant odour; its density at 0° = 1.1055; under a pressure of 775 mm. it boils at 236° to 237°. The boiling temperature of synthetic quinoleine is variously stated at 228° and 232°.

No. 6, 1882.

This issue contains no original communications.

Verhandlungen des Vereins zur Beförderung des Gewerbflusses. March, 1882.

This part contains no chemical papers.

MISCELLANEOUS.

Royal Institution.—The following are the probable arrangements for the Friday Evening Meetings after Easter:—

April 21st.—Prof. Dewar, "Experimental Researches of Henri Ste.-Claire Deville, Hon.M.R.I."

April 28th.—Prof. Abel, "Some Dangerous Properties of Dusts."

May 5th.—Prof. R. Grant, "The Proper Motions of the Stars."

May 12th.—A. G. Vernon Harcourt, "The Relative Value of Different Modes of Lighting."

May 19th.—Sir Frederick Bramwell.

May 26th.—Sir Henry S. Maine, "Sacred Laws of the Hindus."

June 2nd.—H. H. Statham, "The Intellectual Basis of Music."

June 9th.—Prof. Burdon Sanderson, "The Excitability of Plants."

MEETINGS FOR THE WEEK.

MONDAY, 24th.—Medical, 8.30.

Philosophical Club, 6.30. (Anniversary.)

TUESDAY, 25th.—Institute of Civil Engineers, 8.

Royal Medical and Chirurgical, 8.30.

Royal Institution, 3. "History of Customs and Beliefs," by Dr. E. D. Tylor.

Society of Arts, 8. "The Character and Social Industries of the Inhabitants of China, Japan, and Formosa," by Lieut. the Hon. Henry N. Shore.

Anthropological Institute, 8. "Exhibition of Pottery from Silesia," by General Pitt Rivers, F.R.S. "On the Aboriginal Inhabitants of the Andaman Islands, Part II," by E. H. Man.

WEDNESDAY, 26th.—Geological, 8.

Society of Arts, 8. "Telephonic Communication," by Lieut.-Col. C. E. Webster, R.E.

London Institution, 12. (Anniversary.)

THURSDAY, 27th.—Royal, 4.30.

Royal Institution, 3. "The Metals," by Prof. Dewar.

Society of Arts, 8. "The Manufacture of Steel from Phosphoric Pig-iron," by S. G. Thomas, F.C.S., and Percy C. Gilchrist, F.C.S.

FRIDAY, 28th.—Royal Institution, 8. "Some Dangerous Properties of Dusts," by Professor Abel, at 6 p.m.

Society of Arts, 8. "National Necessities as the Bases of National Education," by Dr. Richardson, F.R.S.

Quætt Microscopical Club, 8.

SATURDAY, 29th.—Royal Institution, 3. "History of the Science of Politics," by Mr. F. Pollock.

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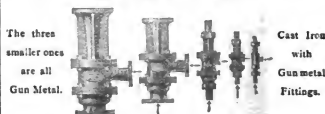
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THE CHEMICAL NEWS.

VOL. XLV. No. 1170.

ON CRYSTALLISED ANHYDROUS GRAPE-SUGAR.

By ARNO BEHR, Ph.D.

ANHYDROUS grape-sugar in a state of purity has so far only been obtained from an alcoholic solution. Two years ago F. Soxhlet found that the best solvent for it is methylic alcohol, from which much larger and better developed crystals can be obtained than from the solution in ethylic alcohol. I have found that it can even more easily be prepared from a watery solution.

The principle that a crystal introduced into the super-saturated solution of the same substance induces crystallisation, has long been applied to the practice of grape-sugar manufacture. In order to hasten the hardening of the sugar, a certain quantity of the already hardened sugar of a previous operation is stirred into the mass. But as the ordinary commercial grape-sugar always contains the hydrate, the crystallisation so obtained is also that of the hydrate. I put the question to myself, What would happen if, instead of the hydrate, I introduced the crystallised anhydrous sugar into a concentrated solution of ordinary grape-sugar. I tried the experiment and must confess that I had not much hope that anything else but crystallised hydrate would be the result, for I expected to see the anhydride transformed into the hydrate within the watery solution. I was agreeably surprised when, on the next morning, I found the glass filled with a neat crystallisation of anhydrous grape-sugar, from which the liquid part could be easily drained. The few crystals of anhydride, far from being transformed into the hydrate, had induced an ample crystallisation of their kind. The explanation of this fact is found in the following:—In its crystalline form anhydrous grape-sugar is not deliquescent, even in very moist weather, and it is stable in comparatively dilute solutions of grape-sugar. I have kept crystals exposed to the atmosphere of the laboratory for months and during moist weather without seeing them lose their sharp outlines and bright appearance, and I have repeatedly found the syrup drained from a crystallisation of anhydrous sugar to contain as much as 26 per cent of water. The limits of concentration, within which this crystallisation can be obtained, are rather wide, but in order to secure a good result the solution ought to contain from 12 to 15 per cent of water. It is well not to allow the mass to cool rapidly or the temperature to fall much below 30° C.; for at a lower temperature, and before the remaining syrup has been diluted by the separation of the anhydrous crystals, concentrated solutions are rather viscous, and this viscosity prevents a free crystallisation. A good temperature is 30° to 40° C. The time within which the crystallisation is completed varies between half a day and several weeks, according to the purity of the mass.

Though it is always well, in order to secure a uniform and speedy crystallisation, to start it by the introduction of some crystals, yet it is possible, and, for sugars of high purity, quite easy, to obtain the same crystallisation by simply keeping the concentrated solutions at a temperature of about 30° C. for some time. Under these circumstances a crystallisation of anhydrous grape-sugar takes place. This behaviour of grape-sugar is also unexpected. Soxhlet, who, a short time ago, took out patents in different countries for the refining of grape-sugar by means of alcoholic liquids, and for the production of a hard crystallised grape-sugar, describes one of his products expressly as the hydrate of the formula $C_6H_{12}O_6 + H_2O$; yet he con-

centrates highly a solution of very pure grape-sugar, and allows it to crystallise at an elevated temperature. I have failed, under the conditions of my experiments, to obtain the hydrate, but that it is possible for the hydrate to crystallise in large and well-developed crystals has been established in 1877 by Halse and Steiner, who analysed a crystallised hydrate of grape-sugar, of which some crystals weighed 4 to 5 grms., and which was readily taken for cane-sugar. This grape-sugar had made the voyage from England to Australia and back, and during this time had undergone the transformation.

A product which has for some time played an important part in the literature of this subject, is Anthon's hard crystallised grape-sugar. As early as 1857, Anthon, in Prague, prepared a very pure sugar by crystallising and pressing the hydrate. He then melted the press cakes without addition of water, and allowed the mass to solidify in moulds. He obtained crystalline masses, which, according to his analysis, contained 47 per cent of water, and for which he claimed the constitution of a half hydrate of grape-sugar of the formula $2(C_6H_{12}O_6) + H_2O$. As he did not drain his crystals, he certainly had nothing but a mixture of anhydrous sugar and the hydrate, the surplus water of the hydrate having been evaporated during the melting. This has already been suggested by Stohmann in the latest German edition of "Musprratt's Chemistry," (vi., 2077).

Crystallised anhydrous grape-sugar, such as I have prepared from a watery solution, has the following properties:—Dried at 30° to 40° C., it does not retain more than 0.2 per cent of moisture, the moisture determination being made at 130° C. It shows a neutral reaction with sensitive litmus-paper. It melts in a capillary tube between 141° and 145° C. It was tested in the polariscope, and showed bi-rotation. Landolt in his book on the optical rotatory power of organic substances ("Braunschw., 1879, p. 184) gives 32.68 grms. as the amount of pure grape-sugar, which, taken instead of the normal weight of cane-sugar, should show 100 on the scale of a Ventake-Solei instrument. It was found that, if this amount was rapidly dissolved in cold water and immediately polarised, it showed a polarisation varying between 202 and 204; if it was allowed to stand for twenty-four hours, 101 to 102. This difference is mainly due to an error in Landolt's figure. This figure is calculated from an assumed specific rotation of $a_D = 53.0$. This is correct only for a concentration of 10 grms. of sugar in 100 c.m. of solution; but for a concentration of 32.68 grms. in 100 c.m., a_D becomes = 53.57, according to Tollens's determinations. Therefore, 32.68 grms. ought to polarise 101.1, while the observed polarisation for mono-rotation was 101 to 102.

These are the facts so far as they refer to chemistry; but in view of the increasing importance of grape-sugar as an article of general consumption, I wish to add a few remarks with reference to the industrial application of these observations.

In the ordinary process of the manufacture of grape-sugar from starch the conditions are such that the resulting product is always far from being pure grape-sugar, however pure the starch from which it was derived may have been. Though a good method for the quantitative determination of starch consists in its conversion with a mineral acid and subsequent determination with Fehling's solution, yet in practice a smooth and complete conversion is not attainable. The reason for this difference lies in the fact that the chemist, for a complete conversion, works with a very diluted solution, while the manufacturer necessarily works with solutions of higher density. At a higher density, however, the acid seems to act on the sugar already formed, and before all the dextrin is converted into sugar the sugar itself is partially converted into something else, which constitutes an impurity of the final product. So far we know very little about the nature of these impurities of commercial grape-sugar, but several chemists have asserted that the residues which remain after fermentation and distillation are more or less in-

urious to the human system. This subject, though, requires a more complete investigation. As the principal use of all the grape-sugar produced is that which is made of it in the manufacture of fermented beverages, beer, and wine, it is easy to understand the rising demand for a purer article.

F. Anthon has, twenty years ago, called attention to the disadvantages arising from the use of impure grape-sugar in wine-making, and suggested a remedy. His suggestion was to refine the ordinary grape-sugar by crystallisation, and the use of a centrifugal machine for the removal of the liquid impurities. He modified this process in so far as he used a strong press instead of a centrifugal machine, and according to the testimony of several chemists really produced an article of remarkable purity. His process seems to have never been used for any length of time on an extensive scale.

Fouchard had already, in 1853, manufactured a refined grape-sugar by allowing grape-sugar solutions to crystallise in barrels, and then withdrawing the liquid portion through a number of holes in the bottoms of the barrels.

Though the principle of these refining processes is correct, yet there is a difficulty inherent in it, which arises from the form and nature of the crystals in which the sugar solidifies. Under ordinary circumstances grape-sugar crystallises from a watery solution as the hydrate in the shape of very fine tablets, which are mostly grouped spherically. Owing to the fineness of the tablets and the capillary attraction it is difficult to remove the impure mother-liquor sufficiently from the crystals by means of a centrifugal machine, and even with a hydraulic press high purity cannot be obtained together with a large yield. It is different with the crystals of anhydrous grape-sugar. They are of a prismatic shape, and form loose aggregations, from which the syrup can be easily removed by centrifugal force, and which lend themselves to a treatment of draining and washing very similar to that of cane-sugar. Under these circumstances it is possible to produce a grape-sugar which compares in purity with block and granulated cane-sugar. A number of applications for such an article readily suggest themselves. The confectioner, the druggist, the manufacturer of condensed milk may use it. In the preparation of certain wines it can safely take the place of cane-sugar, but its principal use ought to be in the kitchen for all those preparations where utmost sweetness is not sought for. It is not so well suited for tea or coffee, though it does not quite so unfavourably compare with cane-sugar, as the books will have it. To obtain a moderate sweetness, equal to that produced by a given amount of cane-sugar, it is not necessary to take two-and-a-half or three times as much as cane-sugar, but only about one and two-thirds times the quantity; at least I have found it so, and so have some of my friends.

Jersey City, April, 1882.

LONDON WATER SUPPLY.*

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. NEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London
Hospital; Medical Officer of Health for Islington; and late
Deputy Medical Officer of Health for the City of London.

(Concluded from p. 171.)

GENERAL CONCLUSIONS.

ALTHOUGH any conclusions that we have ourselves drawn from the large body of facts we have placed before you, would, in whatever form expressed, receive doubtless that measure of consideration to which their greater

* Report presented to the Right Honourable the President of the Local Government Board, on the Composition and Quality of Daily Samples of Water supplied to London during the year 1881.

or less accordance with the facts would entitle them, yet inasmuch as the conclusions to which we have come in 1881 are in complete agreement with those arrived at by the Royal Commission on Water Supply, who made their report in 1869, we prefer, in view of a possible imputation of personal bias, to express our conclusions in the form of extracts from that report, rather than by the use of any language of our own. This Commission, which was presided over by the Duke of Richmond, consisted, in addition, of the then Chairman of the Metropolitan Board of Works, of an Alderman of the City of London, and of three eminent professional men. Their report, we would remind you, constitutes the most recent report having a judicial character* which has been made on the subject of Water supply; and its conclusions are entirely at one with those of a previous report made by a Committee of the House of Commons, appointed to enquire generally into the operations and results of the Metropolis Water Act, 1852.

Extracts from the Report of the Royal Commission on Water Supply.—1869.

Par. 128.—“This Committee (that of the House of Commons), of which Mr. Ayrton was Chairman, inquired fully into the whole subject, and reported at the end of June, 1867.

“As to the main question, they declared they were satisfied that both the quantity and quality of the water supplied from the Thames were so far satisfactory that there was no ground for disturbing the arrangements made under the Act of 1852, and that any attempt to do so would only end in entailing a waste of capital and an unnecessary charge upon the owners and occupiers of property in the Metropolis.

“The water of the Lee they found not only wholesome, but comparing favourably with that supplied to other places. They agreed with the Rivers' Commission that it was liable to serious contamination, but they suggested certain alterations in the remedial measures proposed (see next paragraph), and expressed their opinion that when these were carried out the water supplied by the Companies would be of an unquestionable character.

Par. 129.—“In 1868 an Act (31 and 32 Vic., cap. 154) was passed, to make better provision for the preservation and improvement of the River Lee and its tributaries. It was analogous to the Thames Conservancy Act of 1866, altering the constitution of the managing body, and rendering illegal the admission of sewage or offensive matter into the river, except in the case of certain towns where measures had been adopted for its purification.

Par. 149.—“It admits of no question that the Metropolis ought to be supplied with water that is perfectly wholesome in quality. . . . And if it could be clearly proved that either now, or in a proximate future, wholesome water could not be obtained from the Thames basin, the question of the abandonment of the source would demand prompt attention. . . . We have endeavoured to get the best information possible, from scientific men of the highest reputation, and who have had the best means of making themselves acquainted with the subject, and we have given their evidence its due weight; but we have also been obliged on some points to rely on other considerations in arriving at our decision.

Par. 180.—“But though for these reasons we believe that the organic contamination of the Thames is much less than is commonly imagined, still it would be sufficient to do great mischief, were it not for a most beneficial provision of nature for effecting spontaneously the purification of the streams. . . . The organic compounds dissolved in water appear to be of very

* The late Rivers Pollution Commission, some of whose reports touch incidentally on the question of water supply, consisted during the greater part of its existence of two persons only, a well-known agriculturist, and the eminent chemist whose monthly reports to the Registrar-General were, in respect to their mode of statement and inferences, made the subject of unfavourable comment by the Commission on Water Supply.

unstable constitution, and to be very easily decomposed, the great agent in their decomposition being oxygen, and the process being considerably hastened by the motion of the water. . . . This purifying process is not a mere theoretical speculation; we have abundant practical evidence, which we shall hereafter refer to, of its real action on the Thames and other rivers.

Par. 181.—"It does not follow that all organic matter in water is prejudicial; great mistakes have arisen on this point, as it is often given out that the very suspicion of organic contents of any kind in a drinking water should disqualify it for use. But almost all our drinks other than water owe their distinctive qualities to the varieties of their organic contents, and hence it is clear that the presence of organic matter *per se* is not necessarily prejudicial. It is, however, necessary in potable waters which contain organic matter carefully to distinguish between such combinations as are innocent and such as are noxious; and here lies one of the greatest difficulties.

Par. 193.—"Although these analyses of Thames waters (those made for the Commission by Drs. Frankland and Odling jointly) will require repetition and extension before the exact value of all the facts can be determined, yet as they relate to the river at one season, they may be accepted as relatively correct, and they are sufficient to show at least not only the absence of any increase of objectionable matter in the river from Lechlade to Hampton, but that the variations in the quality, which commence at Lechlade, after showing several temporary changes in many parts of the river's course, fall at Hampton in general to a point as low as at Lechlade,* and in one respect, viz. the organic nitrogen, to a point even lower.

Par. 194.—" . . . And further, we cannot but consider it unphilosophical when, in addition to treating as "impurities" substances perfectly harmless even in much larger quantities, the minute quantities present in a gallon, or any other small measure of water, are multiplied by taking masses of water such as the individual never has to deal with, and given to the public in figures so large as tend to cause misconception and perhaps unnecessary alarm in the minds of those not conversant with all the conditions of the case. It would be as just to speak of the small proportion of carbonic acid present in the atmosphere, equally in populous cities and in the Alps, as an impurity, and to startle those unacquainted with the subject by giving in some large figures the total quantity of that gas present in the atmosphere of London.

" . . . Few waters are free from organic matter, but all organic matter is not objectionable in small quantities.

"It is contended, and no doubt with truth, knowing beforehand the probabilities of the case, that although the soft waters of the mountainous districts of England and Wales contain as much organic matter as the Thames water, there is an essential difference in its quality. Still the evidence is by no means conclusive even on this point. Whilst on the one hand there is clearly far less objectionable matter introduced into the former, on the other hand the remarkable power of oxidation possessed by running water, admitted more or less by all chemists, so destroys and removes organic matter that the water regains in great measure its original purity, either unassisted or else further aided by filtration.

Par. 214.—"The evidence we have collected on this subject (that of the organic impurities) presents great diversities of opinion; but there is one result which, we think, is clearly deducible from the facts before us, namely, that in the present state of chemical science, analysis fails to discover, in properly filtered Thames water, anything positively deleterious to health. Whatever may be the difference of opinion with respect to the time required for the removal of all the objectionable

organic matter, all the chemists agree that in Thames water, taken from the present source and properly filtered, all such matter has disappeared, and that the resulting compounds, such as nitrates, &c., remaining therein are innocuous and harmless.

"Having carefully considered all the information we have been able to collect, we see no evidence to lead us to believe that the water now supplied by the Companies is not generally good and wholesome.

Par. 217.—"We are of opinion that, when efficient measures (referring to the Acts of 1866 for the Thames and of 1868 for the Lee) are adopted for excluding the sewage and other pollutions from the Thames and the Lee, and their tributaries, and for ensuring perfect filtration, water taken from the present sources will be perfectly wholesome and of suitable quality for the supply of the Metropolis.

Par. 260.—"We are of opinion:—That there is no evidence to lead us to believe that the water now supplied by the companies is not generally good and wholesome."

To these extracts from the Commission's Report we will add only a few words, in yet further deprecation of the alarmist statements, chemical and hygienic, so frequently made with regard to London water. And we would first call attention to what is indeed a matter of common knowledge, namely, that the natural conditions of river life, irrespective of drainage from houses and cultivated land, are on the one hand constantly furnishing organic matter to the river water, and on the other hand as constantly destroying this organic matter, so as to keep down any excess. It thus happens that a small proportion of organic matter, appreciably greater in winter than in summer, occurs as a normal constituent of most river waters; a constituent, however, which, as pointed out by the Water Supply Commission, there is not any reason to regard as objectionable. And indeed it has not, we believe, been suggested that Thames water, at Lechlade for instance, would be unsuitable for town supply by reason of its containing a small proportion of organic matter; any more than that Thirlmere Lake and Loch Katrine waters are unsuitable for town supply by reason of their containing a similar small proportion of organic matter. But at the Companies' intake at Hampton, the organic matter in the water of the river is, in respect to quantity, admittedly not in excess of that in the water at Lechlade; while, as regards the nature or quality of the organic matter at the two points of the river, it is unquestionable, that mere chemistry, however refined, has not been able to distinguish a difference, or even to establish the presumption of a difference. Of course, in a strictly chemical sense, the small proportion of organic matter present in Thames water at Lechlade as at Hampton, is an "impurity"; but only in the same sense that the vivifying oxygen by which Thames water is so abundantly aerated is also an impurity. And, in common with the Water Supply Commission, we take it as manifest that this applicability of the word "impurity" in a strictly limited and esoteric sense does not justify its use in a popular sense; and we maintain further, that the natural increase according to season, in the proportion of a minute and objectionable constituent of river water as of lake water does not justify the river water* being stigmatised from time to time as largely "polluted." But despite of all protests, this unfounded use of the words "impurity" and "pollution" will doubtless be continued for some time* to startle those unacquainted with the subject.† Sooner or later, however, we venture to think that these scarecrow terms will follow in the

* It is easy enough, by selecting the period, criterion, standard, and instances, to make a comparison that will exhibit any particular waters in a position of bad pre-eminence. Thus in the month of August, the organic matter, or so-called "pollution," alike of the Birmingham Corporation's water and of the Glasgow Corporation's water, was, according to the figures given in the Registrar General's Report, twice as great as that of the New River Company's water; although, indeed, attention was not called to the circumstance.

* Lechlade, where the main stream of the Thames is formed, is situated 116 miles above Hampton.

wake of their fellow expression, "previous sewage contamination," which, no longer serving to point a moral in the right direction, has been judiciously though tardily abandoned.

But irrespective of chemistry, is there any evidence to show that the Companies' water, supplied as it is to a population of several millions of people, is injurious to their health, or that it constitutes a means of spreading typhoid or other diseases. The answer to this question, must, it would seem, be sought for in statistics—not indeed in selected statistics of short periods, as of a week or fortnight's duration, but in statistics made out on a sufficiently extensive scale to exclude those erroneous inferences to which limited statistics are so especially liable. The answer afforded by statistics of this character

has been made the subject of detailed investigation by one of ourselves (Dr. MEYMOTT TIDY), and we reproduce, together with his remarks thereon, two Tables which he published in the *Journal of the Chemical Society* for May, 1880. So far as we know their accuracy has never been challenged:—

"Let us compare the statistics of death in towns supplied by river water, with those of towns supplied by deep well and spring waters. I have devoted much time to this question, and in the endeavour to obtain a large body of facts upon which to draw some conclusions, I have taken the statistics for 10 years of 18 towns supplied by well and spring water, to compare with the same 10 years' statistics of 18 towns supplied by river water. My results are stated in the following Table:—

TABLE showing the average death-rate, and the number of deaths, &c., from various diseases during 10 years in 18 towns supplied by deep well or spring water, and in 18 towns (omitting London) supplied by river water.

| | Estimated Population. | Average Death-rate. | Diphtheria. | Fever. | Diarrhoea. | Cholera. | Disease of Kidneys. |
|--------------------------------|-----------------------|---------------------|-------------|--------|------------|----------|---------------------|
| 18 towns supplied by wells .. | 889,340 | 22·72 | 1508 | 7549 | 9981 | 632 | 2851 |
| 18 towns supplied by rivers .. | 911,742 | 22·66 | 1329 | 8321 | 7900 | 1046 | 2811 |

TABLE deduced from the above, showing the deaths per year from the several causes per 1000 of the estimated population.

| | Diphtheria. | Fever. | Diarrhoea. | Cholera. | Disease of Kidneys. |
|-----------------------------------|-------------|--------|------------|----------|---------------------|
| 18 towns supplied by wells.. .. | 0·1695 | 0·8488 | 1·1223 | 0·0710 | 0·3205 |
| 18 towns supplied by rivers | 0·1457 | 0·9126 | 0·8664 | 0·1147 | 0·3083 |

TABLES SHOWING THE AVERAGE RATES OF MORTALITY PER THOUSAND OF THE POPULATION FOR THE TEN YEARS 1868 TO 1877, IN THE SEVERAL DISTRICTS IN LONDON AND THE NEIGHBOURHOOD.

Compiled by Mr. BALDWIN LATHAM, C.E., F.G.S., &c.

| Name of District. | Source of Water Supply. | Birth-rate. | Death-rate. | Phthisis death-rate. | Fever death-rate. | Enteric Fever death-rate. | Scarlatina death-rate. | Diarrhoea death-rate. | Cholera death-rate. | Diphtheria death-rate. | Dysentery death-rate. | Estimated Population, 1877. |
|-------------------|--|-------------|-------------|----------------------|-------------------|---------------------------|------------------------|-----------------------|---------------------|------------------------|-----------------------|-----------------------------|
| Lambeth .. | Lambeth and Southwark and Vauxhall Water Companies | 38·55 | 23·30 | 2·46 | 0·61 | 0·32 | 0·92 | 1·00 | 0·05 | 0·13 | 0·02 | 239,190 |
| Wandsworth .. | Southwark and Vauxhall, and Lambeth Water Cos. | 36·02 | 19·85 | 2·04 | 0·41 | 0·20 | 0·83 | 0·93 | 0·05 | 0·12 | 0·02 | 169,890 |
| Totals | | 74·57 | 43·15 | 4·50 | 1·02 | 0·52 | 1·75 | 1·93 | 0·10 | 0·25 | 0·04 | |
| Average | | 37·28 | 21·57 | 2·25 | 0·51 | 0·26 | 0·87 | 0·96 | 0·05 | 0·12 | 0·02 | |
| Greenwich .. | Kent Water Company .. | 37·65 | 22·76 | 2·53 | 0·53 | 0·27 | 0·81 | 1·05 | 0·04 | 0·10 | 0·09 | 110,920 |
| Woolwich .. | Kent Water Company .. | 37·38 | 20·21 | 2·63 | 0·54 | 0·27 | 0·98 | 0·93 | 0·06 | 0·19 | 0·03 | 74,000 |
| Totals | | 75·03 | 42·97 | 5·16 | 1·07 | 0·54 | 1·79 | 1·98 | 0·10 | 0·29 | 0·12 | |
| Average | | 37·51 | 21·48 | 2·58 | 0·53 | 0·27 | 0·89 | 0·99 | 0·05 | 0·14 | 0·06 | |
| Camberwell .. | Lambeth, Southwark, and Vauxhall, and Kent Companies (Kent Company in part of Peckham) | 36·20 | 20·73 | 2·18 | 0·41 | 0·21 | 0·77 | 0·97 | 0·07 | 0·09 | 0·03 | 150,650 |
| Lewisham .. | Lambeth and Kent Water Companies | 31·42 | 15·82 | 1·60 | 0·27 | 0·19 | 0·67 | 0·67 | 0·02 | 0·14 | 0·01 | 64,000 |
| Totals | | 67·62 | 36·55 | 3·78 | 0·68 | 0·40 | 1·44 | 1·64 | 0·09 | 0·23 | 0·04 | |
| Average | | 33·81 | 18·27 | 1·89 | 0·34 | 0·20 | 0·72 | 0·82 | 0·04 | 0·11 | 0·02 | |
| London | | 35·70 | 23·13 | 2·65 | 0·49 | 0·26 | 0·86 | 1·03 | 0·05 | 0·11 | 0·02 | 3,533,454 |

"These details, which, let me add, have been tested in a variety of ways, are remarkable. The 18 well towns had an estimated population of 889,000, and the 18 river towns a population of 911,000. In population, therefore, they were closely comparable. The well towns had an average death-rate of 22.72 per 1000, and the river towns a death-rate of 22.66, a difference of 0.06 in favour of rivers as a water supply over wells. Analysing the details, wells have the advantage in deaths from fever in the proportion of 8.483 per 1000 against 9.126 per 1000 in the case of rivers. Similarly in the case of cholera, wells stand before rivers in the proportion of 0.710 deaths per 1000 in the well towns against 1.147 in river towns. On the other hand, river towns show to advantage in diphtheria, 1.457 deaths per 1000 being registered in river towns against 1.695 in well towns. The difference is most remarkable in the case of diarrhoea, for in river towns 8.644 deaths per 1000 are recorded, whilst in well towns we have an average of 11.223 deaths per 1000. It is worthy of note, in passing, that deaths from diseases of the kidneys are as nearly as possible alike in both.

"At any rate these statistics, as they are on a very extensive scale, prove tolerably conclusively, it appears to me, that there is no evidence to show any manifest difference in the matter of health between towns supplied by wells and those by rivers.

"Again, we have in London certain places supplied with river water, a second series supplied with deep chalk water, and a third series supplied with a mixture of river and chalk water. It is worth our while to compare the death statistics of these districts one with another. Again I am indebted to Mr. Baldwin Latham for the Table (see p. 182), the details of which I have myself verified. (1.) Lambeth and Wandsworth have been selected as districts supplied with river water only, by the Lambeth and the Southwark and Vauxhall Water Companies; (2.) Greenwich and Woolwich, as fairly comparable districts, supplied entirely with chalk water by the Kent Water Company; and (3.) Camberwell and Lewisham have been taken as districts supplied partly by a company deriving their supply from a river (both the Lambeth and the Southwark and Vauxhall in the case of Camberwell, and the Lambeth only in the case of Lewisham) and partly with chalk water. The average of ten years has been taken, and the results show that the death-rate from all causes in the river districts and the death-rate in the well districts are practically identical, whilst the death-rate of those districts receiving a mixed supply is manifestly less than either. But what is more remarkable still is, that the death-rate from enteric fever, from scarlatina, from diarrhoea, from diphtheria, and from dysentery is in each case slightly lower in the districts supplied with river water than in the districts supplied with well water, whilst so far as cholera is concerned the returns in both are identical."

Taking into consideration the results of our extensive series of chemical analyses of the water supplied to London, and the fact that the death-rates of well-water towns and river-water towns are practically alike, and of the further fact that in the Metropolis there is very little to choose, judged by mortality, between districts supplied with deep-well water and districts supplied with river water, any slight difference being in favour of the districts supplied with river water, we are of opinion that the filtered water of the Thames and Lee is unimpeachable in respect of its wholesomeness and suitability for town supply.

We have the honour to remain, Sir,

Your obedient Servants,

W. CROOKES,
W. ODLING,
C. MEYMOOT TIDY.

Reactions of Urine after Use of Balsam of Copaiba.
—M. Thoms.—In searching for uroanthine or indican in urine, the similar reaction obtained after the use of copaiba should be taken into consideration.—*Journ. de Pharmacie.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, April 20, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—
W. L. Goodwin, R. N. Wolfenden.

Dr. RAMSAY then read a paper "On the Atomic Volume of Iodine." The author has determined the atomic volume of boiling iodine. The experiment was somewhat difficult owing to the opacity of iodine vapour; the results of four experiments were 34.07, 39.27, 35.62, 37.79, the mean being 36.69, with a probable error of 0.7749. The numbers deduced by Kopp and Thorpe from the molecular volumes of compounds containing iodine were respectively 37.2 and 36. The author concludes that it may therefore be accepted as proved that elements in compounds occupy the same volume as elements in the free state. Thus, the following elements give values in the free and combined states respectively:—Bromine, 27.13, 28.1; iodine, 36.69, 36.6; sulphur, 21.6, 22.5; phosphorus, 20.9, 20.7. Nitric peroxide also gives values—free, 32.0, and combined, 37.5.

Dr. RAMSAY then read a second communication, "On Molecular Volumes." The author compares the two well-known statements of Kopp—1. In homologous compounds for each increase of CH_2 the molecular volume increases by a mean value of 22. 2. Carbon (C) can replace hydrogen (H_2) without change of molecular volume, with the antagonistic theory of Schröder, which may be shortly summed up in the two statements: All elements occupy the same bulk, or a multiple of that bulk, named a "stere"; and the stere is a variable quantity. Both these theories involve an unwarrantable assumption, viz., that the atomic volumes of liquids are comparable at their boiling-points under equal tensions. The author then proceeds to give experiments designed to test the validity of this assumption, and for convenience sake confines himself to the alterations of the group CH_2 . In the first table the values for this group CH_2 are given as obtained from bodies compared at the boiling-point under a pressure of 760 m.m.; the values in 12 cases vary from 18.03 to 23.23. Great care was taken to ensure the purity of the substances employed—water, methyl alcohol, ethyl alcohol, ethyl ether, isopropyl alcohol, isobutyl alcohol, methyl acetate, ethyl acetate, isopropyl acetate, isobutyl acetate, amyl acetate—and to ensure the accuracy of the results by check experiments. It is obvious from the numbers obtained that the value of CH_2 is not constant at the boiling-point under a pressure of 760 m.m. The next step was to ascertain whether a better agreement is obtainable at pressures lower or higher than the normal. Tables are then given which indicate the volumes at pressures (a) below the normal, (b) at pressures above the normal, but below 10 atmospheres, (c) at pressures up to the critical point. A description of the apparatus with which the results were obtained is also given. A study of these numbers shows (1) that the value of the group CH_2 becomes less constant the higher the pressure. Thus, at a pressure of 20 millimetres, it varies from 17 to 21; at 760 m.m., from 18.03 to 23.23; at 5000 m.m., from 20.26 to 26.88; at 30 atmospheres from 26.1 to 54.3. (2.) That as a rule the value of CH_2 increases regularly in amount with the increase of tension. (3.) That its value, as deduced from methyl alcohol and water, is exceptional. It is clear, therefore, that if CH_2 has a constant value at any temperature, that temperature must be very low. The author then speculates as to the condition of matter, which renders the idea of an invariable molecular volume tenable. The expression molecular volume means not merely the space occupied by the molecules themselves, but this space plus the space occupied by the interstices between the molecules, and the variation of the volume of the group CH_2 .

is probably due to the fact that this latter space is not constant. The author then considers the case of solids crystallising in similar forms, and suggests that in such cases the interstitial spaces are probably identical, and the observed molecular volumes would give the volumes of the molecules plus a constant, expressing the value of the interstitial space; but until this constant is determined no definite conclusion can be drawn. The relative probabilities of the theories of Kopp and Schröder are then indicated, and the author states that Schröder's hypothesis is untenable, and that by his assumption of the variability, within limits of 10 per cent, of the "stere" and the power of doubling, trebling, and quadrupling, if necessary, the number of stereos assigned to any element, he gives to his system an appearance of coincidence with experimental results which it does not really possess.

Dr. JAPP then read a paper "On the Action of Acetone on Phenanthraquinone, both alone and in the Presence of Ammonia," by F. R. JAPP and F. W. STREATHFIELD. In a previous paper the authors studied the action of phenanthraquinone in the presence of ammonia on aldehyde, and in the present paper the action of these two bodies on the ketone-acetone, is investigated. 50 grms. of powdered phenanthraquinone were mixed in a stout flask with 60 grms. of acetone, and 40 c.c. of strong aqueous ammonia added. The flask was corked, the reaction commenced, and the temperature rose, and finally a white granular crystalline powder separated out from the dark-coloured supernatant liquid. The substance was purified from some unaltered quinone; it melted with decomposition at about 130°; analysis indicated the formula $C_{17}H_{11}NO_3$; it is named by the authors acetonequinimide of phenanthrene. This substance dissolves readily in cold concentrated hydrochloric acid, yielding a pale yellow solution, which becomes green, and on, standing, deposits an indigo-blue substance. When much water is added, colourless needles were gradually formed, which, after crystallisation from ether, were obtained in thin colourless blades, melting at 89.5° to 90°; analysis indicated the formula $C_{17}H_{11}O_3$; it is named acetonequin of phenanthrene. If oxalic acid be used instead of hydrochloric acid the same substance, $C_{17}H_{11}O_3$, is formed, but there is no indigo-blue deposit. By treating this compound, $C_{17}H_{11}O_3$, with ammonia the original substance, $C_{17}H_{11}NO_3$, is reformed. By heating, $C_{17}H_{11}O_3$ is decomposed into phenanthraquinone and acetone, and again $C_{17}H_{11}O_3$ can be synthesised by heating these two bodies in sealed tubes to 200°. The authors conclude the paper with some considerations on the constitution of phenanthraquinone.

The following papers, in the absence of the authors, were read by the SECRETARY:—

"A Study of some of the Earth Metals contained in Samarskite," by H. E. ROSCOE. The probable existence of a new metal in this mineral was announced by Delafontaine in 1878, and confirmed by him shortly afterwards, when it was named Philpittium. The most characteristic salt is the soluble formiate, which is deposited in well-defined rhombic crystals, and indeed is the only means (except its constant atomic weight) of distinguishing this metal from terbium or yttrium. Terbium formiate is a white powder, whilst yttrium formiate is much more soluble, and usually deliquescent. The author has investigated the subject, starting with 1500 grms. of samarskite; he obtained about 60 grms. of oxides, containing philpittium, terbium, yttrium, and traces of erbium. These oxides were converted into formiates, and a most elaborate series of fractional precipitations, &c., carried out in order to obtain the pure philpittium salt, but the author entirely failed in procuring an oxide having an unalterable atomic weight of 122. The numbers varied between the atomic weights of terbium and yttrium. The following conclusive experiment was then tried:—3 grms. of terbium having an atomic weight of 147.9 and 3 grms. of crude yttrium with atomic weight 101.4, were respectively converted into formiate. Of each of these two formiates, two-thirds were brought into solution separately, whilst the other

third of the terbium formiate was mixed with the remaining third of yttrium formiate, and the mixture dissolved. Each of the three solutions was then mixed with an equal bulk of alcohol and allowed to stand for the same length of time. The two solutions, containing respectively terbium and yttrium, gave crystals presenting the ordinary appearances of formiates of terbium and yttrium, but the third solution, containing the mixed formiates, deposited rhombic prisms, which could not be distinguished from the supposed formiate of philpittium. These results prove that the mixed formiates of terbium and yttrium are capable of crystallising together in a form ascribed to philpittium.

"On the Spectrum of Terbium," by H. E. ROSCOE and A. SCHUSTER. The authors have mapped carefully the spectrum of this element. A Rutherford grating was used. The specimen of oxide, which ought to contain philpittium in large quantities, should that element exist, showed, with the exception of one line, which could not be identified, only lines belonging to yttrium or terbium.

"On the Action of Thiophosphoryl Chloride upon Silver Nitrate," by T. E. THORPE and S. DYSON. The authors hoped by the above reaction to form a mixed anhydride, one on the type of nitric anhydride, but containing some of the oxygen replaced by sulphur. No such body was formed. The reaction is—



The condensed products afterwards unite to form—



"Note on the Action of the Oxochlorides of Sulphur on Silver Nitrate," by T. E. THORPE.

"On the Behaviour of Zinc, Magnesium, and Iron as Reducing Agents with Acidulated Solutions of Ferric Salts," by T. E. THORPE. The author has carefully investigated the conditions which accelerate or retard the reducing action of the above metals. The maximum reducing action possible with a given weight of zinc is obtained by concentrating the ferric sulphate solution and diminishing the amount of free acid; increase of temperature augments the reducing action. Magnesium is similarly affected by varying conditions, but is inferior in reducing power to zinc. In the case of iron, increase of temperature apparently decreases the reducing power.

"Experiments on the Action of Potassium Amalgam, Sulphuretted Hydrogen, and Potassic Hydrate, respectively, on Tetra- and Penta-thionates of Potassium," by V. LEWIS. Potassium amalgam acts upon tetrathionate, forming hyposulphite; if the amalgam be in excess some sulphide is also formed; similar products are formed with pentathionate. Sulphuretted hydrogen with tetrathionate forms hyposulphite, and precipitates sulphur. Potassium hydrate acts upon pentathionate, forming hyposulphite, sulphite, and sulphur; with tetrathionate, sulphite and hyposulphite are formed. Most of these reactions have been investigated quantitatively.

The Society then adjourned to May 4, when Prof. J. Dewar, F.R.S., will deliver a lecture "On Recent Developments of the Theory of Dissociation."

Experimental Researches on the Thermic Conductivity of Minerals and Rocks.—J. THOULET.—Among the considerations needful for ascertaining the mode of formation of minerals and rocks, one of the most important data is that of the temperature to which they may be brought by convection. The author names "thermic resistance" the time required for a constant quantity of heat which in his experiments is 34°, proceeding from a source at 100° in contact with the lower surface of a rock, may reach the upper surface, at a distance of 0.010 metre. This thermic resistance is a function of the coefficient of conductivity, as defined by Fourier and Lamé. The novelty of the author's method is the substitution of a precise evaluation of times for the determination of temperatures.—*Comptes Rendus*.

NOTICES OF BOOKS.

On the Present Condition of the Royal Military Academy, Woolwich. By an Ex-Professor (who served for twenty-six years.) London: Ballantyne, Hanson, and Co.

THE author of this pamphlet, Mr. C. L. Bloxam, has, as a teacher of chemistry and physics, few equals and no superior in the United Kingdom. For a quarter of a century he fulfilled his duties at the Royal Military Academy ably and faithfully, but he has been ultimately compelled to resign because the authorities, who ought to have supported him, connived at disorder and tolerated a laxity of conduct on the part of the students—we beg pardon, "Gentlemen Cadets"—which to our non-official mind seems eminently out of keeping in a Military College, and which would not be tolerated for a single week in similar establishments in Germany, or even in France. During the first fourteen years of Mr. Bloxam's long term of office down to 1870 everything was on a satisfactory footing. "The cadets were paraded and marched into the lecture-room in charge of a lieutenant, who remained throughout the lecture in order to command silence and attention. The Assistant Inspector also attended the lectures, and the Inspector of Studies was a frequent visitor in his official capacity. The Governor would generally give the sanction of his presence at the opening lecture of each term and on two or three subsequent occasions." The result of such arrangements was what might naturally be expected. The cadets saw the lectures regarded by the heads of the Academy as a serious and important matter; they saw the Professors treated with respect, and they shaped their own conduct accordingly. In 1870, however, a so-called "reform" was inaugurated. It was, we believe, about the time when the cats at the Royal Dockyards were placed upon a reduced allowance of meat and milk, so that possibly the motive may have been short-sighted economy. However this may be, "the appointments of Inspector and Assistant Inspector of Studies were abolished, the officer in charge was removed, the Cadets were no longer marched in, and a circular was addressed to the Instructors admonishing them that 'tact and temper' were to replace the officers in charge, and that, in short, military discipline would cease to be applied to the Cadets in hours of study, and the Instructors would be required to do duty as ushers in an ordinary boarding school." We find it difficult to restrain our "temper" on learning the indignity thus offered, not merely to the person of Mr. Bloxam, but to a professorial chair once occupied by Faraday. For the teachers of a boarding-school, or of a board-school, it may be practicable to combine the twofold, and often heterogeneous, tasks of conveying instruction and maintaining order. But to force the latter task upon men of well-earned eminence, to equip Professor Bloxam in the cocked hat of Bumble, is an outrage to Science. It was on this very ground that we felt indignant at the unworthy treatment offered to Professor A. H. Church at the Cirencester Agricultural College. He and his learned colleagues were expected to reside on the premises that they might take a part in the enforcement of discipline. It appears that the clerical Principal of Cirencester and the Military Governor of Woolwich agree in the degrading estimate they put upon science and upon scientific men. It is utterly impossible for any Professor to concentrate his attention on the performance of experiments which if neglected may prove dangerous, or to engage in complicated calculations if he has all the time to be on the watch to detect breaches of discipline; if he is "interrupted by a shout of laughter caused by the circulation of an obscene jest;" or has to "break off in the middle of a chain of reasoning in order to discover and place in arrest the originator of some disturbance."

It is further remarked that whilst the first Governor under the "new system" did occasionally visit the Chemical Lecture-room and Laboratory, "His successor

attended one lecture only, and on no other occasion visited the chemical class-rooms whilst the Cadets were there. The present Governor has never done so yet."

The following circumstance is exceedingly significant. According to the arrangements made in 1870, the Academy was to be independently inspected by a Board of Visitors, nominated by the Secretary of State for War, and reporting to him yearly. For two years in succession Mr. Bloxam had the opportunity of appearing before this Board. On the second occasion he "called the attention of the Board to the inexpediency of allowing Cadets to obtain leave from the Governor to absent themselves from the class for cricket or football matches without first applying for the sanction of the Professor." This very reasonable remonstrance was attended to, and has been acted on ever since, with good results as far as discipline is concerned. But the writer adds—"I have never since had the opportunity given me of meeting the Board of Visitors." What inference can we draw but that the Heads of the Academy do not wish to enforce good order, and would rather undermine than uphold the authority of the instructors?

As further instances of the manner in which Mr. Bloxam has been treated we select the following:—He had to make application for the lobby of the lecture-room to be painted of a dark colour in order to obliterate the "most offensively obscene drawings and writings" with which they had been decorated by the Cadets and to prevent their reproduction. In reply to his request for this lustration, and for a general cleaning of the walls, &c., of the laboratory and lecture-room, he received a verbal message that there were no funds available! He was, however, graciously permitted to have the work done at his own expense. At the time of this "lack of funds" considerable expenditure was being incurred in completing a luxurious official residence for the Governor. He applied also for an iron rail to be fixed in front of the lecture-table "to prevent the damage to apparatus and the abstraction of specimens, due to the disorderly conduct of the Cadets." This request was refused, and Mr. Bloxam had to have the rail put up at his own cost!

On one occasion some of the Cadets in passing from the laboratory through the lecture-room turned on more than a dozen gas-taps. The premises were filled with an explosive mixture, and had anyone entered with a light the east wing of the Academy would have been a wreck. No investigation was held, and no punishment was inflicted for this offence, though Mr. Bloxam made it the subject of a prompt and urgent report.

As one of the many evil results of the new system, the Professor was obliged to discontinue the *viva voce* examination with which he had heretofore supplemented each lecture, since the cadets only took it as an opportunity for "chaff."

In 1880 he addressed to the Governor a very temperate letter, pointing out the unsatisfactory position of the class arrangements, and making certain very serious allegations. If his statements had been doubted they should have been at least enquired into. This letter was not even acknowledged!

Ultimately Prof. Bloxam determined to resign, and though requested to remain for one year longer from February 8th of the present year, he carried out his intention. We think all persons capable of reasoning, if they read his pamphlet, will agree with us that the treatment he has received for the last ten years has been simply disgraceful. What justification or palliation of their conduct the introducers and upholders of the new "system" (? un-system), and the recent Governors of the Academy have to offer is to us a mystery. If they wished to inculcate insubordination and turbulence in the future holders of Her Majesty's Commission; if they sought to render it impossible for officers of the Royal Engineers and the Artillery to acquire that knowledge of chemistry and physics which are felt to be needed in modern warfare they could but have acted as they have done. But if they considered lectures and laboratory work a farce,

or if they doubted Professor Bloxam's competence, why did they ask him to continue his services? Their conduct seems a sad blend of official insolence and neglect of obvious duty. We hope that public opinion will speak on this subject in tones which cannot be mistaken.

As regards the economy achieved by suppressing the offices of the Inspector of Studies and his Assistant, it is interesting to note that the salary of the Governor, which in 1878 was £1500, was last year raised to £2000, whilst that of the Secretary, which was £400 in 1878, was advanced at the same time to £700!

CORRESPONDENCE.

ESTIMATION OF NITRIC AND NITROUS NITROGEN IN THE STATE OF AMMONIA.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xlv., p. 159, there is a note by Mr. Hugo Tamm, upon the estimation of nitric and nitrous nitrogen by conversion into ammonia during an ordinary combustion analysis, the author slightly altering the well-known soda-lime method by addition of acetate of soda.

Having worked much and long upon this question of estimation of nitro-nitrogen by combustion, I am astonished at the confident expressions used by Mr. Tamm. Having met with many failures, and numerous, though almost complete, results before finding a process which could be relied upon, to be yet told that an agent—acetate of soda, "dry" or not, or marsh-gas—could be employed successfully whilst I had tried and rejected them years ago as unreliable, is a great surprise. Mr. Tamm also tells us he would certainly have succeeded in applying the reactions of sulphide of sodium, and almost dry proto-sulphate of iron, &c., if he had not superseded them by the marsh-gas and soda-lime method. This is also great news, as proto-sulphate of iron was tried and found wanting eight or ten years ago by several chemists.

Permit me to say (as part of the results of over 800 combustions on this subject), for the information of Mr. Tamm and your readers in general, that, roughly, the best partial results can be obtained with crystallised sulphide of sodium favourably mixed with soda-lime; 90 to 97 per cent of the nitrogen can be estimated, but still unrelatively. The next generally best reagent is proto-sulphate, or proto-chloride of iron, crystallised, and duly mixed with soda-lime, but in all cases "dry," or "almost dry," reagents do not succeed, and, even in the published successful method, the presence of H_2O is essential to success, and it is for that reason that ordinary crystallised hyposulphite of soda is used.

With any organic matter, whether acetic acid as an acetate, or other acid, neutral, or basic body, partial results only can be obtained depending upon the degree of intimate admixture of the reagent with the substance analysed, but still not reliable complete results. I am sorry to say this in the face of Mr. Tamm's assertions, but one cannot resist facts repeatedly ascertained. Perhaps Mr. Tamm's method has been undescribed, but we can only take it as given in your pages; and, anxious to see whether, after all, simple acetate of soda and soda-lime would answer, I tried Mr. Tamm's method exactly as given. I used about $\frac{1}{2}$ grm. of pure nitrate of soda for one combustion, and obtained as a result 9.21 per cent of the nitrogen estimated against 16.47 per cent the nitrate contained. I also made a mixture of one quarter pure sulphate of ammonia, one quarter pure nitrate of soda, and a half ordinary superphosphate; beat the whole into a paste, as is usual for a superphosphate analysis, took a portion of rather under a gramme for analysis, cut it up

fine with some kaolin, and burnt it as Tamm directs. The mixture contained 5.30 per cent nitrogen as ready-formed ammonia, and 4.11 per cent of nitrogen as nitrate; together a total of 9.41 per cent. The analysis gave a result of 7.53 per cent only, showing a deficit of 2 per cent!

I hope that Mr. Tamm (whom I have not the pleasure to know personally) will pardon my remarks, which are *bona fide*, but having worked on the subject, having published several notes thereupon in your valuable columns, I am naturally interested in the question, and if Mr. Tamm will refer to the *Journal of the Chemical Society* for March, 1881, he will find there published a process—with results—for the estimation of nitro-nitrogen by combustion, which answers completely with pure substances, and can be applied to a pasty admixture of superphosphate. There is a special reason for dwelling upon this point, as it was difficult to get over, and even do something more. If Mr. Tamm wishes, I will forward him a copy of the reprint, with also some results not therein given; and finally I will mention that this process has been tried by chemists in England and on the Continent, and found satisfactory. —I am, &c.,

JOHN RUFFLE.

April 18, 1882.

COMBINATION OF OXYGEN AND HYDROGEN UNDER THE INFLUENCE OF THE SILENT DISCHARGE.

To the Editor of the Chemical News.

SIR,—Two papers appear in the *Comptes Rendus* of the French Academy, dated November 28 and December 5, 1881, respectively, by MM. Dehérain and Maquenne. The first paper describes the decomposition of water in partially exhausted induction tubes under the influence of the electric effluve without any visible spark. The second paper describes the combination of oxygen and hydrogen gases under similar conditions, sometimes attended with explosion.

Now, in a paper sent by me to the Royal Society on October 8, 1881, and read before that Society last November, but which for some reason has not been published, the following paragraph occurred:—

"In the course of my work with the induced current, I incidentally discovered that a mixture of $O_2 + H_2$ may be exploded by a current of a certain intensity without the agency of the spark. Probably this is due to the production of ozone under these conditions."

I therefore beg to take this opportunity of claiming priority in the observation of the explosion of moist oxygen and hydrogen gases under the influence of the effluve without visible sparks. —I am, &c.,

G. STILLINGFLEET JOHNSON.

Chemical Laboratory, King's College, W.C.

April 21, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 15, April 10, 1882.

The Evaluation of Thermic Conductivity by a Measurement of Times during the Variable State.—H. Lagarde.—It is possible with two plates of the same substance, differing slightly in thickness, to find, by four determinations of time rapidly executed, either the thermic resistance or the coefficient of conductivity, which form an important characteristic constant for various substances.

Electrolysis.—D. Tommasi.—The author demonstrates that when a galvanic current traverses several electrolytes, in order that there may be decomposition, the quantity of calories produced by the battery should be equal to the sum of the calories absorbed by each electrolyte augmented by the calories necessary for overcoming the total resistance of the electrolytes. By calories produced by the battery he means those which are transmissible to the circuit. He has also collected facts concerning the ratio existing between the calories produced by the battery and the calories absorbed by several voltmeters containing water, saline solutions, or melted salts.

Researches on the Solubility of the Aluminates of Lime in Water: Influence of this Solubility upon the Final Setting of Hydraulic Materials.—E. Landrin. The author shows that the calcium aluminates are soluble in water, and are harmful in hydraulic cements. Hence the puzzolani, which contain no soluble aluminates, give excellent results. Ferric oxide plays a totally negative part in the setting of hydraulic cements.

Relation between Isomorphism, Atomic Weights, and Comparative Toxicity in Metallic Salts.—J. Blake.—The author criticises the conclusions drawn by M. Richet from his experiments on fishes placed in solutions of metallic salts, on the ground that poisonous substances, if brought in contact with mucous membranes, act differently from what they do when introduced into the blood. It must also be remembered that different salts have very different coefficients of diffusion. If two salts are dissolved in water in the same proportion, still if they come in contact with a mucous membrane like that which covers the gills, they enter the blood in very different proportions. The speed with which the salts, after having entered into the blood, are eliminated by the kidneys is not the same, and the local action of the salts upon the tissue of the gills may also vitiate any conclusion as to the relative toxicity of the metals drawn from the experiments of M. Richet.

Certain Physical Properties of Camphor Bichloride.—MM. P. Cazeneuve and Didot.—This compound is insoluble in water, to which it imparts, however, its peculiar odour. It is slightly soluble in cold alcohol, but dissolves to any extent at the boiling-point. It is very soluble in chloroform and in carbon bisulphide, and extremely soluble in ether, liquefying even in the vapour of ether. From this solution it does not easily crystallise, the ether being retained energetically. Camphor bichloride is insoluble in acetic acid, in which camphor dissolves. It is soluble in aldehyde, forming a liquid more dense than water. The specific gravity of camphor bichloride is 4.2; its melting-point is 96°.

Peptones and Alkaloids.—C. Taniet.—This paper is a reply to that of M. J. Béchamp in the last number of the *Comptes Rendus*.

Moniteur Scientifique, Queneville.
April, 1882.

Azo-Colouring Matters.—O. Wallach.—An account of azo-benzin-resorcin and azo-toluen-resorcin, taken from the *Berlin Berichte*.

Compounds of the Indigotic Group.—A. Baeyer.—A description of isatogenic acid, indoxyl-ether and acid, ethyl-indoxyl-ether, nitroso-ethyl-indoxyl-ether, indoxyl-ether, indoxyl-sulphuric acid, and disatogen, taken from the *Berlin Berichte*.

Syntheses by means of Phenyl-acetylene.—MM. Baeyer and Landsberg.

A New Base Homologous with Quinoline.—MM. Dœbner and Miller.—These two memoirs are also taken from the *Berlin Berichte*.

Quinine and Quinidine.—Z. H. Skraup.—The author treats of the oxidation of quinine, of quinic acid and its salts, of the acetylation and oxidation of quinic acid, of

its behaviour with hydrochloric acid with the formation of xantho-quinic acid, and the action of heat upon the latter.

Preparation of Colouring-Matters by the Action of Aromatic Nitro-Derivatives upon Phenols and Polyatomic Alcohols in Presence of Dehydrating Agents.—H. Brunner.—From the *Berlin Berichte*.

Apparatus for the Distillation of Mercury in a Vacuum.—A. W. Wright.—This paper, taken from the *American Journal of Science*, cannot be intelligibly reproduced without the accompanying illustration.

The Latest Improvements in the Manufacture of Artificial Indigo.—The preparation of indigo is still too costly, and its use in printing is attended with such inconveniences that the attempts at its production have been for the present discontinued in the two great establishments which had entered upon the undertaking. Among recent improvements have been the replacement of the oil of bitter almonds and acetic anhydride by benzylic bromide or chloride and anhydrous sodium acetate. Cinnamic acid cannot be quantitatively transformed into ortho-nitro-cinnamic acid, which alone is capable of yielding indigo. A quantity of the para-acid is formed at the same time. Indoino is a new compound obtained by M. Baeyer from ortho-nitro-phenyl-propionic acid. It presents certain analogies with indigo, but is yet distinct.

Anniversary Banquet to M. Chevreul.—On March 5th, a banquet was given by the French National Society of Agriculture to its President, M. Chevreul, in commemoration of the 50th anniversary of his election.

Journal de Pharmacie et de Chimie.
March, 1882.

Chemical Studies on the Skeleton of Vegetables (2nd Part).—MM. E. Fremy and Urbain.—From the *Comptes Rendus*.

Decomposition of Racemic Acid.—E. Jungfleisch.—Already noticed.

Cinchona Tree yielding Cinchonamine.—G. Planchon.—A pharmacological paper.

Study on Essence of Savory.—A. Haller.—Already noticed.

Journal für Praktische Chemie.
No. 3, 1882.

Further Contributions to the Chemistry of Bile.—G. Hüfner.—The author raises the question, What is the respective proportion of taurocholic and glycocholic acids in ox-gall in such cases where the gall at once crystallises on the addition of ether and hydrochloric acid, and in such where this experiment fails? It appears that the crystallisation it most complete and rapid where glycocholic acid largely predominates.

An Air Thermometer.—Designed by O. Pettersson and executed by F. Müller.—This instrument cannot be intelligibly described without the accompanying figure.

Maltose.—Dr. E. Meissl.—The author examines the specific rotatory power, and gives the practical rule that the number of grammes of the active substance in 100 c.c. of solution may be found to ± 0.05 gram by reading off the degrees of rotation at 17.5° and multiplying by 0.362. The rotatory power becomes less and less as the concentration and the temperature increase, and if seen by the sodium light it may be represented in a solution containing P per cent of anhydrous maltose at the temperature T , by $[\alpha]_D^{17.5} = 140.375 - 0.01837 P - 0.095 T$. The rotatory power of freshly-prepared solutions is lower by 15° to 20° than that of old solutions or such as have been boiled. Maltose resists hydration under the action of diluted acid about five times more strongly than does saccharose. It is most readily converted into dextrose if heated for three

hours with 3 per cent sulphuric acid. Chlorine acts less energetically upon maltose than upon dextrose or saccharose, the acid produced being distinct from gluconic and glycolic acid.

Communications from the Laboratory of Agricultural Chemistry at the University of Königsberg.—H. Ritthausen.—These consist of a memoir on the albumenoid bodies of hemp-seed and of the crystalline albumen of hemp and castor oil seed; on the composition of the crystalline albumen of pumpkin seeds; and on the behaviour of lead chromate in combustions and with oxygen. The author remarks that combustions with lead chromate sometimes give larger quantities of carbon than were expected or calculated. The lead chromate evidently contained a quantity of organic matter, of carbon, or of other bodies volatile at a strong heat and capable of absorption by potassa lye. He therefore recommends that in all cases the lead chromate should be ignited in a current of oxygen before use.

Diformine, from Glycerin.—P. van Romburgh.—This compound is a neutral colourless liquid of sp. gr. 1.304. It begins to decompose at 175°, the chief product being allyl formate along with allylic alcohol, formic acid, water, and carbonic acid mixed with a little carbonic oxide.

No. 4, 1882.

The Occurrence of Allantoine and Asparagine in the Young Leaves of Trees.—E. Schulze and J. Barbieri.—The authors have demonstrated the presence of these bodies in the young leaves of the birch, the horse chestnut, and the oriental plane. The occurrence in the vegetable organism of allantoine, a body so closely connected with urea and uric acid, is not without interest.

The Cholesterines.—E. Schulze and J. Barbieri.—Two distinct cholesterines occur in the shoots of lupins. The cholesterines are very widely distributed in plants, and must be regarded as constant ingredients of protoplasm. But their significance for the vital process of plants is still unexplained. They do not belong to those constituents of seeds which are consumed in the process of germination in the absence of light.

Open Letter to Professor Kolbe.—A. Ladenburg.

Explanatory Remarks in Correction of the Errors contained in the above Open Letter.—H. Kolbe.—Matters of personal controversy.

Contribution to a Right Appreciation of Dr. J. L. W. Thudichum's Critique on a Memoir concerning Certain New Cerebral Compounds, by E. Parcus.—E. Drechsel.—The author points out that pbenosine, according to Dr. Thudichum's memoir, forms with cerebrine a mixture containing more carbon than either of its constituents.

Justus Liebig's Annalen der Chemie,
Band 211, Heft 2.

The Chemical Constitution of Organic Bodies with Reference to their Physical Properties (Fourth Part).—J. W. Bruehl.—We can only give the author's principal conclusions:—The refractive power of a body decreases continuously with its gradually increasing combination with oxygen; it becomes smaller the more atoms of oxygen enter into its composition, just as is the case with the combustion-heat. Quite corresponding is the action of the removal of hydrogen or its substitution by oxygen, so that the combustion-heat of the hydrocarbons is greater than that of equal weights of all those bodies formed by the oxidation of hydrocarbons, such as the alcohols, aldehydes, acids, &c. The differences of the constants of neighbouring members of an oxidation-series, decrease both thermically and optically with the increasing molecular weight, the chemical structure being analogous. There appears a complete harmony between the optical and the thermic properties of halogen-substitutes of or

ganic compounds. The specific refraction-power of these bodies, and their combustion-heat, is the smaller for equal weights the more the hydrogen is replaced by a halogen. The values are smaller in the bromo- than in the chloro-products, and smallest in the iodo-compounds. The optical and the thermic phenomena in the homologous series agree likewise completely. Both the refracting-power and the combustion-heat of equal weights of homologous compounds increase continuously with the increasing proportions of carbon and hydrogen. The differences for the increment CH_2 , in case of both constants, decrease with the increase of molecular weight. Polymerisation decreases both the refracting-power and the combustion-heat of equal weights of bodies, both constants decreasing the more strongly the higher is the molecular weight of the new-formed compound. The double union of carbon atoms which strengthens the power of refraction heightens also their combustion-heat. Both constants of bodies containing such double unions are greater than the constants of the isomers in which such unions are wanting, and are replaced by a twofold catenation of oxygen with carbon, or by an annular grouping, whether of carbon atoms or of oxygen and carbon atoms. The universal agreement of the thermic and optic behaviour of the liquid organic bodies makes it also probable that the combustion-heat of such bodies, as well as their refracting-power, are heightened by a twofold union of the carbon, though in a less degree than by twofold union of carbon atoms. The so-called double union gives, therefore, not a more intimate but a feeblere attraction of the atoms than simple catenation of the same. The assumption of a double union is therefore in direct contradiction with facts. Substances in which manifold unions are assumed are in reality unsaturated, i.e., such in which the power of affinity of the atoms is not added to its maximum. As the final results of his investigations the author puts forward the proof of the correlation of the refracting-power and of the combustion-heat, that is, the energy of liquid organic compounds. Further, the proof that the so-called double union represents an increased dispersion or disaggregation of their atoms, and consequently a loosening of their connection; hence a double, or indeed a plural, union of atoms does not exist.

Action of the Halogen Compounds of Hydrogen upon Compound Ethers.—Eugen Sapper.—The author considers that Friedel's theory fully explains the formation of esters by the introduction of the halogen hydrides into mixtures of organic acids and alcohols.

Furfural.—E. Fischer.—The author describes the benzoindol derivatives of furfural. Among these he particularly treats of furoine, benz-furoine, furile, benz-furile, together with their derivatives.

MEETINGS FOR THE WEEK.

- MONDAY, May 1st.—Medical, 8.30. (Ann. Oration.)
Royal Institution, 2. (Annual Meeting.)
TUESDAY, 2nd.—Institute of Civil Engineers, 8.
Pathological, 8.30.
Royal Institution, 3. "History of Customs and Beliefs," by Dr. E. D. Tylor.
WEDNESDAY, 3rd.—Society of Arts, 8. "The Fire Risk Incidental to Electric Lighting," by Thomas Bolas, F.C.S. Obstetrical, 8.
THURSDAY, 4th.—Royal, 4.30.
Royal Institution, 3. "The Metals," by Prof. Dewar.
Chemical, 8. "Recent Developments of the Theory of Dissociation," by Prof. Dewar.
FRIDAY, 5th.—Royal Institution, 8. "The Proper Motions of the Stars," by Professor R. Grant, at 9 p.m.
Society of Arts, 8. "Experience of an European Zemindar (Landowner) in Behar," by James Mylne.
Geologists' Association, 8.
SATURDAY, 6th.—Royal Institution, 3. "History of the Science of Politics," by Mr. F. Pollock.
Physical, 3. "On the Mercurial Thermometer," by F. D. Brown.

THE CHEMICAL NEWS.

VOL. XLV. No. 1171.

SOME OF THE DANGEROUS PROPERTIES OF DUSTS.*

By F. A. ABEL, C.B., F.R.S.,
President of the Institute of Chemistry.

WHEN dealing with the subject of so-called accidental explosions, in a discourse delivered to the Members of the Royal Institution, in March, 1875, the lecturer pointed out that combustible, and especially inflammable substances, if sufficiently light and finely divided to allow of their remaining for some time suspended in air in considerable quantity, so as to form an intimate mixture with it, may, when ignited in this condition, produce explosive effects. The combustion of the finely-divided particles which, under such conditions, are first inflamed, at once communicate flame to those in their immediate vicinity, and combustion is thus transmitted by and through the surrounding mixture of dust and air with a rapidity regulated by the inflammability of the dust, and by the proportion and state of division in which it is distributed through the air. If a rapidly-burning mixture of this kind is confined, its combustion will be attended by explosive effects, the degree of violence of which is determined by the combustibility of the dust, by the quantity of mixture ignited, and the nature of its confinement. Its behaviour is indeed quite similar to that of a mixture of inflammable gas or vapour and of air; at the instant of its ignition each dust-particle is to a more or less considerable extent converted into inflammable vapour, or is, at any rate, surrounded by an envelope of burning vapour, so that if the particles are in sufficiently close proximity to each other, the rapidly successive development of vapour from them as the flame spreads, gives rise to a condition of things very like that which obtains when an inflammable gas, or vapour, originally existing as such, is mixed with air.

Even the most inflammable solid, in the form of dust, must be mixed in large proportion with air, must, indeed, be present in the form of a dense cloud, in order that the transmission of flame may proceed continuously from the portion first ignited to surrounding parts of the mixture. A dense cloud of *Lycopodium* dust in air will transmit flame with rapidity and violence throughout its whole extent, but if the particles in the cloud be not in very close proximity, the application of flame to it will only produce short flashes in the vicinity of the source of flame, and the fire will not spread to surrounding particles.

The difficulty of maintaining, if only for a brief period, a sufficiently uniform and highly charged mixture of air with even a very light inflammable powder, to ensure the propagation of flame through it, and the circumstance that, with powders which are not very highly and completely inflammable, only some portion of the combustible matter is actually burned when flame is applied to the mixture of dust and air, necessitate the presence of a proportion of dust more or less considerably exceeding that which is proportionate to the oxygen supply in the volume of air with which it is mixed, if flame is to be transmitted by the mixture.

This condition is not difficult of fulfilment in practical operations in which inflammable dust is dealt with, and flame may consequently be transmitted upon a large scale through mixtures of inflammable dusts and air, with a

rapidity calculated to produce more or less violently explosive effects, as has been demonstrated by many accidents in works where manufacturing operations have been attended by the production and escape into the air of large quantities of inflammable dust. The accidental inflammation of sulphur dust in chambers in which its pulverisation has been carried on, has given rise to more than one considerable and somewhat violent explosion. Cotton mills have been known to become rapidly fired by the ignition of, and transmission of flame by, mixtures of cotton dust and air, and very quickly spreading conflagrations originating from dust explosions have occurred in other works dealing with even less inflammable and dust-producing materials; thus, at the Garancine Mills, at Sorgues, an explosion occurred in 1878, consequent upon the ignition of a mixture of air with the dust of that substance. But the most numerous and extensive calamities connected with the accidental ignition of mixtures of light inflammable dust and air have occurred in flour- and rice-mills.

The cause of many disastrous explosions and fires which occurred in flour-mills at Budapest in Hungary, at Fridate in Germany, in other parts of the Continent, and in England, prior to 1872, appeared enveloped in much mystery, until Dr. Watson Smith directed attention to the fact that an Austrian observer had apparently traced their origin to the ignition, by flame or some incandescent body (such as sparks produced by the millstones), of mixtures of air and the dust of meal and husks formed during the grinding of corn or subsequent treatment of flour. The occurrence of a very serious explosion and fire at the Tradeston Flour-Mills, in Glasgow, in January, 1872, caused that gentleman to direct public attention to what appeared the true explanation of these disasters, and on the occasion of that catastrophe, when several persons were killed and a number injured, the subject was carefully investigated by Messrs. Rankin and Macadam. The origin of the explosion was conclusively traced to the striking of fire by a pair of millstones, through the stopping of the feed, and the consequent friction of their bare surfaces against each other; the results being the ignition of the mixture of air and fine flour dust by which the millstones were surrounded, and the rapid communication of flame thereby to the mixture of dust and air which filled the conduits in communication with the exhaust box: this being the common receptacle into which the mixture of dust and air is drawn, by an exhaust fan, through the conduits communicating with the several mills. From the exhaust box, where a portion of the suspended flour dust was deposited, the air, still laden with dust, passed, in the Tradeston as in other flour-mills, to another chamber, called the stive room, where a further quantity of the flour dust would deposit. A connected series of channels and larger enclosed spaces was therefore filled with a dust-laden atmosphere, through which flame was so rapidly transmitted from the millstone where the first ignition occurred as to produce violent explosive effects, which succeeded each other with very great rapidity in different parts of the building. The production of the blaze at the millstones was observed to be immediately succeeded by a crackling noise as the flame rapidly spread through the conduits to the exhaust box upon an upper floor, whence a loud report almost at once proceeded.

Messrs. Rankin and Macadam's inquiries elicited the facts that other flour-mill explosions had been attended by a similar succession of effects to those above indicated, and that at the Tradeston Mills themselves a less violent explosion, resulting in the hursting open of an exhaust box, attended by injury to some workmen, and the blowing out of windows and loosening of tiles, had taken place on a previous occasion. In the later accident, the more violent explosion of the exhaust box was followed by other distinct explosions in distant parts of those extensive mills, to which fire was led by the dust-laden air existing in the many channels of communication, and in

* A Lecture delivered at the Royal Institution of Great Britain, Friday, April 28, 1882.

which the cleansing and sifting operations, all attended by the escape of dust, were carried on.

Messrs. Rankin and Macadam ascertained that accidents of this nature at flour-mills were frequent occurrence, especially since the exhaust arrangements had been applied to the larger flour-mills, and in their report they point out that it seems scarcely possible to guard against such accidents, though their frequency may be reduced by adopting efficient precautions for avoiding the stoppage of the feed to the millstones and the access of nails or other iron particles to the stones; and by prohibiting the employment of naked lights in the vicinity of the mills or dust passages. They also suggest that measures should be taken to reduce, as far as possible, the violence of explosions and the risk of injury to life and property, by constructing all receptacles into which the dust-laden air is drawn or passed from the mills, &c., as lightly as possible, so as to offer little resistance to the sudden expansion due to the ignition of an inflammable mixture, and by placing such receptacles as the exhaust box and stive room outside the building.

Since the publication of Messrs. Rankin and Macadam's valuable report, the accidents at flour mills appear, however, to have been scarcely less numerous or disastrous than before the date of the Tradeston catastrophe. Thus, in September, 1874, a similar, though less serious, explosion occurred at the Port Dundas City Mills; and in May, 1878, another flour-mill explosion, quite unparalleled for its destructive effects, occurred at Minneapolis, Minnesota, where eighteen lives were lost and six distinct corn-mills were destroyed. Mr. Peckham, writing after the event from the University at Minneapolis, states that two dull explosions rapidly succeeding each other were heard by him, and on looking towards the manufacturing part of the city a large volume of black smoke was seen to envelop the spot where the Washburn A Mill stood, a column of smoke being at the same time projected to a height of several hundred feet. A storm was blowing at the time in the direction from the Washburn Mill to other mills in the neighbourhood, and in about five minutes from the time that the explosion was heard five neighbouring mills, with adjoining premises, were in flames. Persons who were in close vicinity to the scene of the calamity at the time of the first explosion heard a succession of sharp hissing sounds, doubtless caused by the very rapid spread of flame through the dust-laden air in the passages leading from the mills to the exhaust-box, and, at the instant of the explosion, the Washburn A Mill was observed to be brilliantly illuminated from top to bottom. The nearest mill to the latter was 25 feet distant, and appears to have exploded directly the flames burst through the first mill. The explosion of a third, 25 feet distant from the second, followed almost immediately; and the other three mills, about 150 feet distant in another direction, were at once fired. Windows were thrown out of buildings about a quarter of a mile distant, consequent upon the back rush of air following the explosion, and portions of the building materials were projected to very considerable distances. The cause of the explosion was carefully enquired into (by Messrs. Pick, Peckham, &c.), and it was attributed to fire being generated by the stoppage of the feed to a pair of stones, or by the accidental passage of some very hard substance between them. The consequent explosion of dust-and-air mixture round the stones and in the communicating passages added, by its concussion, to the quantity of dust suspended in the air in different parts of the mill, and a second more violent explosion was thus immediately brought about. The attention of Professor Lawrence Smith was directed to the subject of flour-mill explosions by this accident, and in a letter to M. Dumas, of May 4th, 1878, which was published in the *Annales de Chimie et de Physique*, he states his conviction, based upon experimental enquiry, that such accidents are due to the formation of explosive mixtures of finely-divided organic matters (such as flour) with the air, and refers to this as a "revelation" of the existence of a previously unknown

danger connected with an important industry, being apparently unaware of its elucidation by Rankin and Macadam, and Watson Smith in 1872.

Attention has again been recently directed to this subject of flour-dust explosions by a fatal and extensive calamity of the kind which occurred at a flour-mill at Macclesfield in September, 1881, and has been made the subject of an interesting report to the Home Secretary by Mr. T. J. Richards, of the Board of Trade, in which he confirms the conclusions of Messrs. Rankin and Macadam, and repeats the recommendations made by them.

In this particular case, again, there appears to have been no doubt that the inflammation of the dust and air mixture surrounding a particular pair of millstones was due to the stones remaining empty for some time, sufficient heat being consequently developed to ignite some portions of flour-dust existing between the bearing surfaces. One of the owners of this mill deposed that he had seen flame produced by stones when remaining empty, and that the appearance of the stones in question convinced him that flame had been thus produced. A very dry grain was, moreover, being ground at the time of the explosion. A strong consensus of opinion appears to exist that it is very difficult, with the best arrangements for feeding the millstones with grain, to guard against their running empty occasionally, and there is no doubt that on these occasions portions of flour are exposed to heat sufficiently great to char and sometimes even to ignite them. In connection with this effect of the heat to which portions of flour may be exposed between "dry" stones, the opinion of an "experienced person" (quoted as a regrettable one by Mr. Richards) deserves not to be lost sight of. It is to the effect that a stive room can at all times be safely entered with a naked light "except when there is observed the peculiar odour which is noticed there when one of the millstones has been previously running empty." It is not difficult to demonstrate that fine flour very thickly suspended in air will produce with the latter an inflammable mixture, through which flame will be rapidly transmitted: there is also no doubt that if, as is frequently the case, the enclosed dust and air mixture in the air-passages of a mill is somewhat warm, the propagation of flame through the mixture will be facilitated. But experimental observations which the lecturer has had occasion to make in connection with another branch of the subject of this discourse, lead him to consider it not impossible that the development of even very small quantities of inflammable gas or vapour from flour particles which become heated between "dry" stones to an extent to be charred, may, in some cases, decidedly facilitate the propagation of flame by a particular mixture of dust and air, which might otherwise only be bordering upon an explosive mixture.

Mr. Richards calls attention, in an appendix to his report, to four very disastrous fires which had occurred in flour-mills at Wakefield, York, Liverpool, and Depford, within two months of the completion of his report, the origin of the fire being in each case unknown. There is no doubt that the number of fires occurring in corn- and rice-mills, the origin of which is wrapped in obscurity, is very great; and it is stated upon good authority that only about 30 per cent of the explosions in flour-mills which can be actually substantiated are made public, the miller being unwilling to direct increased attention to the risks of his business, which, as it is, have given rise to the establishment of high rates of insurance upon corn-mills. If efficient measures can be adopted in mills for preventing the dispersion of fine flour-dust by other than the comparatively imperfect contrivances for promoting its partial deposition (as in the exhaust box and stive room), flour-mill explosions will certainly be reduced in frequency and importance. The efficiency of at any rate one simple device for arresting the dust, by a species of filtration of the air which is removed from the millstone chambers, seems to have been already decisively demonstrated by practical results, and there appears reason to hope that the millowner will ere long have no valid excuse for per-

mitting a continuance of conditions favourable to what have appeared to be hidden risks of danger to his property and to the lives of those whom he employs.

There appears no doubt that some instances of explosion or of very rapidly spreading fire in flour-mills have been ascribed to the employment—accidentally, or with the permission of those in authority—of naked lights in the vicinity of particular parts of the factory where dust may be thrown into the air in large quantities. An explosion from this cause occurred at the mills of Messrs. Ellis and Co., of Bradford. A spout from a sieve having become choked, a man removed the lid; a quantity of dust at once flew out, and the mixture, meeting either a lamp in the man's hand or a naked gas flame close by, exploded, rendering the man insensible; the flame passed along an enclosed belt to a box containing a fan which was driving a blast of air into five purifying chambers: these purifiers were fired simultaneously, and the explosion then passed to the adjacent exhaust purifiers, and thence to the dust room, so that the mill was fired throughout almost immediately. In another instance the floor of a meal chamber broke, letting through the floor, which, on falling into the air, was ignited by a flame in the vicinity, and speedily fired the mill. Judging from statements made at a recent meeting of the National Association of British and Irish Millers, the opinion is entertained by many millowners that the running of millstones empty must not be credited with too great a share in the origination of explosions or fires in mills; but that many are caused by the so-called accidental ignition (by naked flames) of dust and air mixtures. If such be the case grave responsibilities are incurred by millowners and managers who permit the existence of lights other than safety lamps in localities where there is any possibility of a considerable quantity of dust becoming suspended in the air, or do not establish and strictly enforce regulations prohibiting the carrying of naked lights in or near any working part of the mill.

The important part played by coal-dust, which exists in greater or less abundance in all coal-mine workings, in aggravating and extending the injurious effects of fire-damp explosions, was originally pointed out with great force by Messrs. Faraday and Lyell, in the report which they submitted to the Home Secretary, in 1845, on the explosion at the Haswell Collieries in September, 1844, and on the means of preventing similar accidents. It does not come within the scope of this discourse to examine into the chief part of this most interesting and instructive report, which deals exhaustively with the cause of the explosion and the means of guarding against the recurrence of such a calamity; but the lecturer, having had occasion to study carefully what has been published on the subject of coal-mine explosions and their causes within the last three years, cannot forbear pointing out that the observations and conclusions published by Faraday and Lyell thirty-seven years ago have been repeatedly re-clothed with the garb of originality by workers who have but extended and amplified the original observations of those eminent men.

After discussing the subject of the accumulation of fire-damp in the goaves of the mines, its dislodgment by the drawing of juda, by falls of the roofs in the goaves, and by changes in atmospheric pressure, its diffusion into the surrounding air in the mine-ways, its ignition by a defective lamp, and the spreading of the flame to the gas-mixture, with which the goaf was charged, the reporters say—"In considering the extent of the fire from the moment of the explosion, it is not to be supposed the fire-damp was its only fuel; the coal-dust swept by the rush of wind and flame from the floor, roof, and walls of the works would instantly take fire and burn, if there were oxygen enough present in the air to support its combustion; and we found the dust adhering to the faces of the pillars, props, and walls in the direction of and on the side towards the explosion, increasing gradually to a certain distance as we neared the place of ignition. This deposit was in some parts half an inch, in others almost an inch thick; it ad-

hered together in a friable coked state. When examined with the glass it presented the fused round form of burnt coal-dust, and when examined chemically, and compared with the coal itself reduced to powder, was found deprived of the greater portion of the bitumen, and in some instances entirely destitute of it. There is every reason to believe that much coal-gas was made from this dust in the very air itself of the mine, by the flame of the fire-damp, which raised and swept it along, and much of the carbon of this dust remained unburnt only for want of air.

"At first we were greatly embarrassed by the circumstance of the large number of deaths from choke-damp, and in the evidence that *that* had been present in very considerable quantities compared with the small proportion of fire-damp, which, in the opinion of those in and about the works just before, must have occasioned the explosion. But, on consideration of the character of the goaves as reservoirs for gaseous fuel, and the effect of dust in the mine, we are satisfied that these circumstances fully account for the apparent discrepancy."

On January 17th, 1845, Faraday delivered a discourse to the members of the Royal Institution, in which he dealt with the substance of the above report, and with the experimental inquiry made by himself with reference to the provision of means for preventing a recurrence of such disasters as that at Haswell. In a brief account of this lecture published in the number of the *Athenæum* following its delivery, the substance of his remarks relating to the effect of coal-dust is given in these words:—"The ignition and explosion of the (fire-damp) mixture would raise and then kindle the coal-dust which is always pervading the passages, and these effects must in a moment have made the part of the mine which was the scene of the calamity glow like a furnace."

(To be continued.)

ANALYSIS OF BEET-ROOT AND SORGHUM CANE.*

By P. CASAMAJOR.

In the United States, for the last twenty years, many attempts have been made to manufacture sugar, in a commercial way, from beet-root and from the sorghum cane. Such attempts continue to be made at this day, and although there is no predicting what results may be obtained in the future, I believe that heretofore these attempts have not been successful.

There are many persons who believe that cane-sugar can be made commercially from the sorghum cane, while others believe that beet-root is preferable to sorghum. The partisans of beet and those of sorghum differ widely in their estimates of the comparative values of these two sources of sugar. There is only one way of settling the question, which is to produce beet or sorghum which will yield good results. I have had occasion to examine several samples of beet-root raised in the Northern States, and one of sorghum, and the results obtained were in all cases very unfavorable.

The object of this communication is to call attention to the processes by which we may ascertain beforehand the quantity of sugar which may be obtained from a given weight of beet-root or of sorghum cane. It is nearly useless to try to ascertain the yield of a saccharine juice by experiments on a small scale, as such experiments never yield results analogous to those which can be obtained on a large scale with improved apparatus.

Beet-root or sorghum cane can only be considered by the sugar manufacturer as so much raw material. To estimate the value of either, the manufacturer should follow exactly the course that a refiner follows to ascertain

* A paper read before the American Chemical Society, December 1881.

the commercial value of a raw sugar. A refiner knows that, from a given quantity of raw sugar, he can obtain a certain portion of pure or nearly pure sugar, and a certain quantity of molasses, which will not yield any crystallisable sugar. Therefore, if he can ascertain the total quantity of sugar in raw sugar, and the portion which will remain in the molasses, the difference will be the pure sugar which he will obtain in refining.

It may be urged that account should also be taken of a certain quantity of sugar lost during the process of refining, but this loss is due to causes entirely independent of the composition of any raw sugar under examination, and it should be left out of the calculation.

The composition of molasses from a well-regulated sugar-house is pretty nearly constant. If raw cane-sugars are used in a refinery, the composition of the molasses which will not yield any sugar crystals will be very nearly as follows for a syrup of density equal to 40° Baumé:—

| | |
|-------------------------|-----|
| Sugar | 37½ |
| Soluble impurities .. . | 37½ |
| Water | 25° |

A refiner may obtain, as residue, a syrup containing a smaller percentage of sugar, but we may assume, for the purpose of comparing one sample of raw sugar with another, that the above will be the composition of the molasses obtained in refining.

For the sake of convenience, in comparing one product with another in a sugar refinery, the composition of each product is sometimes stated in the *dry state*, or on the supposition that the product contains no water. Water is easily added, and it may be taken away by evaporation without affecting the quantity of pure sugar obtainable from a given commercial sugar. The quantity of sugar in a product reduced to dryness, compared to the total substances, is called *coefficient of purity* or *quotient of purity*.

Referring to the composition of the sugar-house molasses given above, we may see that its *coefficient of purity* is 50, which means that in cane-sugars 1 per cent of soluble impurities prevents the crystallisation of 1 per cent of sugar.

It has been argued that the coefficient of purity of molasses is not a safe guide for calculating the yield of pure sugar from a given sample of raw material.

There would be some foundation for this if the coefficient of purity of the molasses of a given refinery varied within very wide limits. The contrary is, however, the case. Thousands of tests, extending through several years, have convinced me that the coefficient of purity of molasses may be kept within very narrow limits. The coefficient is not always 50. Some refiners prefer to keep it somewhat lower; but the coefficient 50 answers very well for calculating the quantity of pure sugar obtainable from a raw cane-sugar.

To apply the above, let us suppose that we have a raw sugar whose coefficient of purity is 92. The composition of the sugar, supposed dry, would be—

| | |
|--------------------|----|
| Sugar | 92 |
| Impurities | 8 |

As 8 parts of impurities prevent the crystallisation of 8 parts of sugar, the yield of the above dry sugar would be 92—8=84 p. c.

The results which can be obtained from a given weight of beet-root sugar are somewhat different from those which cane-sugar will afford. A series of tests made in the principal sugar-refineries of Paris show that the coefficient of purity of beet molasses seldom goes below 52, and is generally 55. From this we may deduce the rule that in beet-root sugar 1 p. c. of impurities prevents the crystallisation of 1·2 p. c. of sugar.

The composition of sorghum molasses, from which all the crystallisable sugar has been separated, has not been ascertained, as far as I know. From the analogy between sorghum and the sugar cane we may assume that, for

sorghum sugar, 1 p. c. of soluble impurities prevents the crystallisation of 1 p. c. of sugar.

The difficulty with beet-roots and sorghum cane grown in this country is principally that the coefficient of purity of their juices is not sufficiently high. Whenever a product is obtained whose coefficient of purity is high enough, the quantity of juice in a certain weight of roots or of cane may be ascertained, and this presents no difficulty. If, however, the coefficient of purity is not sufficiently high, there is no use in making further determinations, as there cannot be any profit in working a juice of low grade.

The coefficient of purity of a juice is determined very quickly and accurately by using a process which I first described in the *American Chemist* for October and November, 1873. This process is described more fully and in better form in the *Moniteur Scientifique* for March, 1877. In a late book on sugar analysis, published by Van Nostrand, it is said that this process is advisable when a balance is not at hand, but that it does not give as satisfactory results as Balling's process, which is mentioned as the *direct process*.

As my process is in use in most of the important refineries in the United States, I do not feel called upon to defend it. A constant use of it for several years shows that the results it gives agree within at least 1 per cent, and generally within less than ½ per cent. This process is founded on this—that the pure sugar in 100 c.c. of a solution is given by multiplying the indication of the optical saccharometer by 0·26048 when a Ventzke instrument is used, or by 0·1653 for the Duboscq saccharometer. On the other hand, the total quantity of substance in solution is represented by the degree Balling, multiplied by the specific gravity.

The coefficient of purity is obtained by dividing the first product by the second. If we call the saccharimetric test S, the specific gravity P, and the Balling degree B, we shall have coefficient of purity =

$$\frac{S \times 0.26048}{B \times P}$$

This may be written—

$$\frac{S \times 0.26048}{B \times P}$$

If for every degree Balling we calculate the quantity—

$$\frac{0.26048}{B \times P}$$

we may form a table of factors by which to multiply the saccharimetric degree to obtain the coefficient of purity of a solution.

We may, instead of the Balling degree, determine the specific gravity, and, for any specific gravity, use the factor corresponding to—

$$\frac{0.26048}{B \times P}$$

In the articles above referred to tables are given for Balling degrees between 5° and 15°, and for Geiler's specific gravity spindle, ranging from 1·005 to 1·1050. For any other degree Balling, or any other specific gravity, the factors may be easily calculated from the formula given above.

The specific gravity may be determined by a balance, and the factor may be obtained by the following formula, in which the Balling degree does not enter:—

$$\frac{0.1}{P - 1}$$

in which P is the specific gravity. This is for Ventzke's instrument. For the Duboscq saccharometer the factor is given by—

$$\frac{0.0628}{P - 1}$$

To test a lot of beets for coefficient of purity the juice should be taken so as to represent the average juice of the lot. A wedge-shaped piece should be cut out of every

root picked out for analysis. The thin edge of the wedge should be at the axis of the root, and the angle of each wedge should be the same for every piece. All the wedges may be rasped on a common grater, and the pulp obtained should be pressed in a cloth so as to obtain the juice. This is immediately neutralised with lime, and heated, by which a thick black precipitate is obtained. The liquid, after filtration, is light and clear enough to be placed in the tube of the optical saccharimeter. The density of the filtered liquid should be taken to determine the coefficient of purity, as the juice of beets can always be defeated with a little lime.

The juice of sorghum cane is easily obtained by crushing with a hammer and wringing the cane with the hands, if no special apparatus is at hand.

If the coefficient of the purity of a juice is sufficiently high, we may in the next place determine the quantity of juice in a certain weight of the raw material.

The quantity of juice in the pulp obtained by rasping may be got at by drying a certain weight of the pulp and determining the water in the pulp by loss. We also determine the water in the juice by taking the difference between 100 and the Balling degree. As all the water in the pulp is in the juice, we have—

$$\text{p. c. juice in the pulp} = \frac{\text{p. c. of water in the pulp.}}{\text{p. c. of water in the juice.}}$$

As to what constitutes a sufficiently high coefficient of purity, this should be left to the judgment of the parties interested. I may, however, call attention that in the North of France, in 1879, a beet was not considered as fit to work for sugar, the coefficient of purity of whose juice was below 79. For 100 parts of dried juice the composition would be—

| | |
|--------------------|----|
| Pure sugar | 79 |
| Impurities | 21 |

We have seen that in beet juice x part of impurities prevents the crystallisation of $\frac{1}{2}$ parts of sugar; therefore the yield would be—

$$79 - (21 \times \frac{1}{2}) = 79 - 25.2 = 53.8 \text{ p. c.}$$

I have had occasion to analyse several samples of beet-roots grown in the United States. Those which gave the highest coefficient of purity were from Delaware, the coefficient of purity of the juice being 63 per cent. The yield of sugar of the dried juice would be—

$$63 - (37 \times \frac{1}{2}) = 63 - 44.4 = 18.6 \text{ p. c.}$$

Most of the beet-roots I tested had a coefficient of purity below 50, and they could not, therefore, yield any sugar.

The coefficient of purity of the juice of a sorghum cane which I tested lately was 44, and of course no sugar could be obtained from this juice.

It is almost unnecessary to state, in conclusion, that the processes described are applicable to the sugar cane, and to other plants with saccharine juices.

ESTIMATION OF CHLORINE WITH THE AID OF GOOCH'S METHOD OF FILTRATION.

By DAVID LINDO.

It is generally considered that chlorine can be estimated with great exactness by the gravimetric method.

Chloride of silver being slightly soluble in water, especially in hot water, a small minus error may occur if the latter is employed to wash with, but this can be prevented by adding a little nitrate of silver to the water, as recommended by J. P. Cooke (CHEMICAL NEWS, vol. xlv., p. 235).

On the other hand, the precipitate retains occluded matters with great force. Error from not completely removing these often more than compensates for slight loss

occasioned by the use of hot water alone, or merely acidulated with nitric acid, or by the manipulations necessary when paper filters are employed.

According to Fresenius ("Quantitative Analysis," Seventh Edition, p. 170) we can, with great care, always obtain by this method 99.9 to 100.1 for 100 parts of chlorine taken. I presume Fresenius means when using paper filters, in which case the time required to make an estimate is generally six hours.

The limits of error here laid down are often reached, according to my experience, when paper filters are employed, and no silver nitrate added to the wash water.

Though sufficiently near for most purposes, greater accuracy in chlorine estimates may sometimes be desired. By adopting Gooch's method of filtration and Cooke's suggestion, with a few other simple precautions, a much higher degree of accuracy can be attained with less manipulation and expenditure of time than by the usual method.

This is shown in the results given below, obtained in estimating the chlorine in a very pure sample of chloride of potassium.

The sample had been prepared with care from purified chloride of potash. I failed to detect any trace of impurity in 2 grms. of it submitted to a searching examination.

As about 0.5 grm. was used in each analysis, if any impurities were present the quantity must have been too minute to affect the results in the slightest degree. Ten grms. of the nitrate of silver employed were also examined. Except a minute trace of what appeared to be lime, no impurities were found. The solutions used in the estimates contained 1 grm. nitrate of silver in 20 c.c.

The perforated platinum crucible employed was of the following dimensions:—Height, 1 inch; diameter at top, 1 inch; diameter at bottom, $\frac{1}{2}$ inch. It had a light dish-shaped cover, and when in use was fixed in a hole made in a vulcanised india-rubber stopper, which had been previously digested at a gentle heat for some time in a solution of potash, to remove loose particles of sulphur from the surface.

A 10 per cent solution of the KCl was prepared, the salt and water being accurately weighed. To test its correctness a weighed portion was evaporated to dryness, with due precaution, in a Lawrence Smith crucible, gently ignited, and weighed.

| | |
|----------------------------|--------------|
| Weight of solution | 5.2962 grms. |
| Weight of residue | 0.5296 " |

The following atomic weights were employed:—

| | |
|-------------------|--------|
| Chlorine | 35.46 |
| Silver | 107.93 |
| Potassium | 39.13 |

being the numbers adopted by Fresenius.

Method.

Weighed the solution in a light glass stoppered bottle, and turned it into a deep porcelain capsule, about 4 ozs. capacity, provided with a well-formed lip and a handle. Rinsed the bottle with 25 c.c. distilled water. Added solution of nitrate of silver in about the proportion of 25 c.c. to 0.5 grm. KCl and 2 c.c. pure nitric acid, sp. gr. 1.2. Heated to boiling-point, and kept at this temperature for some minutes without allowing violent ebullition, and with constant stirring, until the precipitate had assumed the granular form. Allowed to cool somewhat, and then passed the fluid through the asbestos.* Washed the precipitate by decantation with 200 c.c. of very hot water, to which had been added 8 c.c. nitric acid and 2 c.c. dilute solution of nitrate of silver containing 1 grm. of the salt in 100 c.c. of water. The washing by decantation was performed by adding the hot mixture in small quantities at a time, and beating up the precipitate

* The pump must always be started before connecting with receiver.

well with a thin glass rod after each addition. The pump was kept in action all the time, but, to keep out dust as much as possible during the washing, the cover was only removed from the crucible when the fluid was to be run in.

Put the capsule and precipitate aside, returned the washings once through the asbestos so as to obtain them quite clear, removed them from receiver, and set them aside to recover excess of silver. Rinsed receiver, and completed the washing of the precipitate with about 200 c.c. of pure cold (20° C.) water. Half of this was used to wash by decantation; the remainder to transfer precipitate to crucible with the aid of a trimmed feather, and finish the washing in the crucible, the lumps of chloride of silver being broken down with the glass rod. Removed the second filtrate from receiver, and passed about 20 c.c. 98 per cent alcohol through precipitate. Dried at 140° to 150° C.

Exposure for half an hour to this temperature was found more than sufficient to dry the precipitate completely, and rendered a second heating and weighing quite unnecessary.

Twelve consecutive experiments by this method gave the results recorded below. The estimates were all made at night, the time required for each being about an hour and a half, drying included.

| Nos. | Weight of KCl taken in Grams. | Weight of AgCl obtained. | Per cent of Cl. |
|------|-------------------------------|--------------------------|-----------------|
| 1 | 0.50115 | 0.9635 | 47.55 |
| 2 | 0.50638 | 0.9735 | 47.54 |
| 3 | 0.54416 | 1.0465 | 47.56 |
| 4 | 0.49092 | 0.9439 | 47.55 |
| 5 | 0.49369 | 0.9492 | 47.55 |
| 6 | 0.50778 | 0.9763 | 47.55 |
| 7 | 0.49563 | 0.9529 | 47.55 |
| 8 | 0.54491 | 1.0477 | 47.55 |
| 9 | 0.45678 | 0.8782 | 47.55 |
| 10 | 0.46154 | 0.8873 | 47.54 |
| 11 | 0.51290 | 0.9864 | 47.56 |
| 12 | 0.51412 | 0.9886 | 47.55 |

Average 47.55.

Theory requires 47.54 Fresenius.

Do. 47.59 Miller.

The precipitate admits of very accurate weighing; no desiccator is required. The film of moisture which all bodies condense on their surfaces having been deposited by allowing the precipitate to cool completely, no further absorption takes place.

The precipitates were very white after drying, and dissolved in strong solution of ammonia without residue. On melting in porcelain they lost weight only to the extent of three-tenths of a milligramme for each gramme.

The loss by washing with 200 c.c. cold water (20° C.) was found by experiment to amount to about two-tenths of a milligramme with precipitates weighing about a gramme. No correction is therefore required, as the two slight errors about balance each other.

It might be supposed that, after washing so persistently with the hot mixture, very little pure cold water would be required to remove remaining traces of impurity. In previous experiments, however, in which 100 c.c. of cold water were used, the precipitates (each weighing about a gramme) sometimes showed faint purple spots on drying, and the results were generally slightly above the truth; yet, I should state that in those experiments care had not been taken to granulate the precipitates before washing them.

Four estimates were made of a sample of HCl solution, the specific gravity of which, at 27° C., was 1.090, indicating 18 to 19 per cent of HCl. The results are given below.

Nitrate of silver solution was used in the proportion of about 19 c.c. for each gramme of the HCl solution taken; 200 c.c. of the hot mixture and 200 c.c. of cold water were used to wash with in each analysis.

| Wt. of HCl Solution taken in Grams. | Weight of AgCl obtained = HCl. | Per cent. |
|-------------------------------------|--------------------------------|-----------|
| 1.8356 | 1.3451 = 0.342058 | 18.635 |
| 2.0272 | 1.4854 = 0.377737 | 18.633 |
| 1.4659 | 1.0742 = 0.273169 | 18.635 |
| 1.8513 | 1.3570 = 0.345085 | 18.640 |

Falmouth, Jamaica, B.W.I.,
April 5, 1882.

NOTE.—The Editor will be pleased to receive the further communications promised by Mr. Lindo on this method of analysis.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING MARCH 31ST, 1882.

By WILLIAM CROOKES, F.R.S.

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and C. MEYMOTT TIDY, M.B., F.C.S.,
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To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

April 1st, 1882.

SIR,—In this, our fifteenth monthly report, we lay before you the results of our analyses of the 189 samples of water collected by us during the month of March, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 189 samples, three were recorded as "slightly turbid," and five as "very slightly turbid." The remaining 181 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from March 1st to March 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 27 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 27 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 27 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 27 samples from the mains of the West Middlesex Company the whole were found to be well filtered, clear, and bright.

Of the 27 samples from the mains of the Lambeth Water Company, the whole were found to be well filtered, clear, and bright.

Of the 27 samples from the mains of the Grand Junction Company, two were found to be "slightly turbid," and two "very slightly turbid," the remaining 23 samples being well filtered, clear, and bright.

Of the 27 samples from the mains of the Southwark and Vauxhall Company, one was recorded as "slightly turbid," and three as "very slightly turbid." The remainder were well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

So much stress being often laid upon the excess organic matter commonly alleged to be present in the

water-supply of London, we would call special attention to the results of our determinations of organic carbon made during the past three months. The average amount of organic carbon found in the 23 samples of water examined for this constituent in January was 0.196; that found in the 23 samples examined in February, was 0.150; and that found in the 27 samples examined in March was 0.144 part in 100,000 parts of water; showing a gradual decrease in the proportion of organic carbon, and consequently of organic matter with the advance of the season. Taking the whole of the 73 samples of water examined for organic carbon during the period of January 1st to March 31st, the average proportion amounted to 0.162 part in 100,000 parts of water. Multiplying this proportion of organic carbon by 23, to get roughly the proportion of organic matter, the average quantity of organic matter is in this way found to constitute $\frac{1}{1000}$ th of a per cent of the water; or to amount to somewhat over a quarter of a grain (0.28 grain) per gallon. Calculating on the same basis, in one sample only of the 73 did the quantity of organic matter amount to half a grain per gallon, and in two other samples only did it approach to that proportion.

Taking into consideration this freedom from excess of organic matter, and the general excellence of the water in respect of clearness and absence of colour, and more especially its state of abundant aëration, we would endorse the opinion of the Royal Commission, who last reported on the subject, to the effect that the water supplied by the London Companies is "perfectly wholesome and of suitable quality for the supply of the Metropolis."

We have the honour to remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ON THE DETERMINATION OF PHOSPHORUS IN IRON.

By J. LAWRENCE SMITH, Louisville, Ky.

In recent years it has been a matter of considerable interest to determine the amount of phosphorus in the iron used in the arts, especially in that form of it known as pig-iron; in fact, since the manufacture of steel by the process of conversion known as Bessemer process, it has become a necessary procedure to ascertain the peculiar fitness of the cast-iron for this purpose; and has a bearing also upon the commercial value of pig iron. It is not many years ago that a few thousandths in the difference in the amount of phosphorus in two lots of pig-iron had but little effect upon its commercial value, while now, its presence affects it to the extent of several dollars value per ton.

Formerly but little reliance was to be placed upon the analytical estimate of the amount of these small percentages of phosphorus in iron, and uniform results were not furnished by different analysts. It was not until the use of an acid solution of molybdate of ammonia* was employed, that reliable results were to be had. Many years previous (in 1852), when I established the constant presence of phosphorus in meteoric iron, I was obliged to devise a process which, while it gave very good results, was not applicable to the present use.

The so-called molybdic acid process did not at first satisfy all chemists, and in hands of all did not give the uniform results desired, and even at the present time, modifications are constantly being sought after.

The molybdic acid process, as first used, was to precipitate the phosphorus from a nitric acid solution

of the iron by an acid solution of the molybdate of ammonia, re-dissolve the molybdate of ammonia in ammonia, and precipitate the phosphorus by chloride of magnesia and ammonia, and estimate the amount of phosphorus from the phosphate of magnesia.

The reasons for not estimating the phosphorus by the first molybdate precipitate were, first, the supposed indefinite nature of the precipitate, and secondly, the occasional presence of free molybdic acid in the precipitate; it was also recognised that the large amount of iron in the solution interfered materially with the precipitation of all the phosphorus, and it was made very apparent that the phosphorus must be concentrated into a small portion of the iron before commencing the process of analysis.

With these facts well established to my mind, I have been engaged off and on for two or three years examining the question of the determination of phosphorus in iron and steel, making several hundreds of variously modified experiments, and repeating the details of processes adopted by different chemists.

I first tried the solution of from one to three grms. of iron or steel in aqua regia, and precipitating by the molybdic solution, with all the iron present and without separating the silica; but the process gave no satisfaction, whatever way the phosphorus was ultimately weighed; nor did the evaporation to dryness over a water-bath and re-dissolving with a little nitric acid materially improve it. It became very evident, as already recognised by several English and American chemists, that silica must not be in the solution in which the molybdic precipitate was made; and, furthermore, that the larger portion of iron must be eliminated from the solution before this precipitation was attempted. The chemist of the Burdon Iron Works, Troy, and of the Pennsylvania Central Railroad gave me their experience on the subject.

In describing the following method, ultimately adopted as affording the most speedy and accurate results, I give but little else than slight modifications of methods already employed by others, with such detail of manipulation as facilitates uniform method of operation.*

Quantity of Iron employed.—It is customary to employ 1 gm. for pig iron, and 2 to 3 grms. for malleable iron and steel; but in my own practice I employ but 1 gm. for all varieties of iron; for even where the iron or steel contains one-thousandth and less of phosphorus, I get as satisfactory results as where 2 and 3 grms. are employed.

Solution.—The iron, say 1 gm., is placed in a porcelain capsule of about from 100 to 150 c.m., and 3 or 4 c.m. of water added; the capsule is placed on a water-bath, and 10 to 15 c.m. of aqua regia is added little by little; the aqua regia is prepared in advance in the usual way with 2 parts chlorhydric acid and 1 part nitric acid. The contents of the capsule are now evaporated to dryness over the water-bath or more speedily on an iron-plate; the capsule with its contents is then placed in an air-bath and heated from 140° to 150° C. for from 30 minutes to 1 hour—thus rendering all the silica insoluble; 3 or 4 c.m. of chlorhydric acid with an equal quantity of water are added to the dry residue, and then warmed gently over a water-bath or lamp; the iron is re-dissolved, a little more water added, the solution filtered with the filter-pump; the filtrate placed on a narrow graduated measure of 100 c.m. capacity and sufficient water added to make the liquid contents 100 c.m.; the whole is well shaken to make the solution uniform. The next step is to concentrate all the phosphorus into a limited amount of the iron.

Concentration of the Phosphorus.—From 90 to 92 c.m. of the last solution is placed in a capsule of 300 or 400 c.m. capacity, either of porcelain or platinum—the latter I use by preference—and 100 c.m. of water added; the iron oxide is now reduced to iron protoxide by soda sulphite or

* Method of making described in "Fresenius's Analytical Chemistry."

* S. Peters has used a process nearly the same as the Burdon Iron Works, Troy

ammonia sulphite.* I prefer the latter, and prepare it in the manner mentioned in the note; the ammonia sulphite I used at the suggestion of Mr. S. Peters, which he stated to me was used advantageously by himself and others. Two or three centimetres of the ammonia sulphite is added to the iron solution and the contents of the capsule are boiled until all the sulphurous acid is driven off, this stage of the process being recognised by the sense of smell. By putting a small drop of the solution on the end of a glass stirrer into a weak ammonia solution we readily recognise the complete conversion of the oxide, for the precipitate is nearly white. Of course during the whole of the above process the solution is acid, with the excess of chlorhydric acid. Ammonia is now added slowly to the warm solution until a little of the greenish precipitate remains undissolved; about 20 c.m. of acetic acid is now added to the solution (which immediately re-dissolves the precipitate), and then 1 or 2 c.m. of ammonia acetate solution; finally, the 8 or 10 c.m. of original solution remaining in the graduated glass is added with 200 or 300 c.m. of water.

The whole contents of the large capsule is boiled gently from one-half to one hour, and if necessary the water re-newed as it is evaporated. The result is the formation of a basic per-salt of iron containing practically all the phosphorus that was originally in the grm. of iron used.

Separation of the Phosphorus from the above Precipitate.—With a filter-pump on a 3½ inch filter, the last precipitate is collected in 15 or 20 minutes; the precipitate is not washed, but a mixture of 5 or 6 c.m. of chlorhydric acid, with an equal quantity of water, is warmed in the capsule in which the boiling has taken place, so as to dissolve the adhering oxide of iron; the hot acid solution is thrown on the filter in the funnel, detached from the pump, the filtrate is readily dissolved and passes in some convenient vessel, and the filter washed once or twice; this solution is placed in a porcelain capsule and evaporated to dryness over a water-bath or on a hot plate. I prefer the former, although it takes a longer time. To the dry, but not over-heated residue is added 1 to 2 c.m. of nitric acid, with an equal quantity of water; this will furnish a clear solution if there be no titanium in the iron; if the latter be present, there will be formed a flocculent precipitate that can be readily separated by a filter prior to the last treatment.

The last Treatment.—The solution now need not be more to 20 c.m. to which ammonia is to be added until the precipitate first formed is no longer re-dissolved; then add a few drops of nitric acid to clear up the solution completely, in which the phosphorus is supposed to have been concentrated. 30 c.m. of molybdic acid solution is now added to the last solution in a small beaker which is then warmed for 15 or 20 minutes to a temperature of 80° C., and agitated with a glass rod. The phosphorus is precipitated as the double ammonia-salt, and settles as a chrome-yellow powder in less than 30 minutes, and is ready for collection on a double filter,† although I commonly allow two hours or more time to elapse before filtering and washing with the filter-pump. As the filter is very small it is readily washed with a little distilled water.

After washing, the double filter is placed in an air-bath heated to about 120° C., and in about 30 minutes weighted by separating the filters, the complete dryness is verified by a second heating in the air-bath.

Of the phospho-molybdate every 100 m.g. will contain

* Equal parts of ammonia and water are placed in a bottle and an excess of sulphuric acid passed through; the operation lasts for several hours, using a mixture of charcoal and sulphuric acid. Once prepared it keeps very well, when kept from the light.

† When I filter a precipitate to be weighed on the filter, a double filter is used, each of the same size; they are weighed one against the other and exactly balanced by the weights; on the lighter one a mark is put with pencil, and the number of m.g. that it is lighter than the other. As only a 24 or 3 inch filter is used, the difference in weight between the filters does not usually exceed 10 or 20 m.g. I always keep a number of these double filters (with the difference marked on them) ready for this purpose or any other.

1·63 m.g. of phosphorus, or 3·74 m.g. of phosphoric acid. The result of this method of analysis will indicate a very minute quantity of phosphorus less than what is contained in the iron, but so small as not to affect the practical result, and will be more accurate, certain, and speedy than if estimated as magnesium sulphate.

Cold-Short Iron.—It has been customary to attribute the cold-shortness of certain iron to the presence of phosphorus. Now, after working on this problem in rolling mills, I have found that the phosphorus cannot alone account for this peculiarity. Very often I have taken a 1 inch and 1½ inch iron that was very cold-short and working them down to smaller sizes, as ½ inch bars, &c., found that very good merchantable iron is produced, capable of being bent and forged cold or hot as well as any good quality of iron, although the phosphorus in the large and small iron is the same in quantity. I would not say that phosphorus has no effect on the cold-shortness of iron, but I would remark that whatever effect it has is very much modified by the manner of working the iron. And this opinion is sustained by that of others who have had much to do with the working of iron.—*American Journal of Science.*

PROCEEDINGS OF SOCIETIES

PHYSICAL SOCIETY.

Saturday, April 22nd, 1882.

Prof. CLIFTON, President, in the Chair.

New Member, Dr. E. Hopkinson.

The PRESIDENT announced that copies of the Report of the Lighting-rod Committee could be obtained from Dr. Guthrie, Science School, South Kensington, price 5s. per copy.

A paper was then read by Mr. W. F. STANLEY, "On the Evidence of a Flowing Liquid moving by Rolling Contact upon the Interior Surface of a Pipe." In his experimental work on "Fluids," published last year, the author has endeavoured to show that liquids flowing in a tube move by rolling contact on or past the resistant surfaces of solids, and upon like principle that the moving parts of a flowing liquid move by rolling contact on the more quiescent parts of its own mass, so that in no case is there any element of sliding, gliding, or shearing motion, such as is generally assumed. Further experiments tend to support this view in the case of liquids flowing through pipes. The difficulty in the experiments arose from the friction of the pipe impeding the free motion of the particles. The principle was investigated by allowing liquids of various kinds—such as solutions of mastic varnish—to flow through pipes, the liquids containing colouring matter or air particles to assist the eye. The author illustrated the effects by diagrams on the screen.

Dr. W. H. Stone, Mr. Blaikley, Dr. Guthrie, and the President, offered some remarks on the paper.

Mr. J. M. WHIPPLE exhibited the magnetograph curves obtained at the Kew Observatory during the past week, showing the progress of the recent magnetic storms. After stating that two unusually large spots were now passing over the sun's disc, he remarked that although the magnets at Kew were somewhat disturbed on the 14th, they were nearly stationary until the night of the 16th, when about 11·45 p.m. they became strongly affected, and from then till 8 p.m. on the 17th the magnetic storm raged. The horizontal component of the earth's magnetic force was at one time reduced more than 0·05 m.m. (m.g.s.) below its average value, and the vertical component by about 0·07 of the same units. This happened about 6 a.m. of the 17th. A little after noon of the same day both forces became so increased that the light spot left the scale of the instrument for nearly two hours. A second riot of magnetic disturbance commenced at about

3.40 a.m. of the 20th, and was violent up to 2 p.m., subsiding gradually until 7.45 a.m. of the 21st. During this period the magnetic force, though fluctuating largely, did not experience such great changes of intensity as were indicated by that of the 17th. Mr. Whipple then alluded to the work of Prof. W. G. Adams, and suggested that sun spots only produced such effects when cutting certain lines of force, which he imagined might extend for a limited angular distance round the earth's radius sector.

Prof. ADAMS pointed out the desirability of increasing the number of self-recording magnetic observations, especially in the Southern Hemisphere; and after mentioning that the French were about to equip such an observatory at Cape Horn, expressed the wish that the Cape of Good Hope Observatory might again be provided with magnetometers.

The Rev. S. J. PEARCE remarked on the exceptional nature of the storm which he had seen recorded at Brussels, and stated that in Belgium the telegraphic service had been disorganised by it. Attention was also called to the auroral displays in America.

Mr. LECKY, Dr. GUTHRIE, the President, and others spoke on the general phenomena of the storms.

It was then announced that the meetings of the Society in May would be held on the 6th and 20th instead of on the 13th and 27th, as previously announced; also that the Society would meet at the Clarendon Laboratory, Oxford, on June 17, by invitation of the President.

NOTICES OF BOOKS.

Modern Metrology: a Manual of the Metrical Units and Systems of the Present Century, with an Appendix containing a Proposed English System. London: Crosby Lockwood and Co.

We have here a work on a subject much neglected, and, in consequence, little understood, but by no means lacking in importance. We are, at present, as regards the question of measures, in a transition state. The inconveniences and complications of our old system are generally admitted, and there are many persons of authority in such matters who advocate the introduction of the French or metric system as the only alternative. It must be remembered, however, that whilst the general principles of a decimal division, and of a harmonious relation between the standards for linear measure, capacity, and weight, are admittedly convenient, the metric system, as it now stands, and as it is used in France, Germany, &c., is open to certain objections. The metre is not, as was formerly supposed, the ten-millionth part of the length of a meridian from the Pole to the Equator, but a mere approximation, and consequently must be pronounced an arbitrary unit. "The unit of cubic measure, the litre, which was nominally the thousandth part of a cubic metre, at a later date lost its purely scientific and theoretical value by becoming a measure containing a kilo. weight of distilled water at 4°, while the measure itself was supposed to remain at 0° C."

The standard weight, the "kilogramme des archives," is, of doubtful value. Its nominal weight is of course 1000 grms., whilst the calculated weight of a cubic decimeter of water, according to Stampfer in 1830, is 999.653 grms., and according to Kupffer in 1841, 999.989 grms."

But there are other disadvantages in the metric system as it now stands of a more practical nature. The names of our traditional weights and measures are short, and with few exceptions monosyllabic. If we look at a table of metric weights and measures, we find the grades expressed by words of three or four syllables. Some of the names, too, are liable to be confounded with each other, such as decimetre and decametre, decigramme and decagramme.

Again, the figures used in our ordinary system as factors

and divisors are small, and easily dealt with mentally. Two, four, six, eight, or ten ounces are magnitudes which persons of the meanest capacity can remember. But suppose we translate these quantities into their metric equivalents we get such figures as 58, 126, 174, 232, 290 grms.—numbers much less easily remembered. If we know the price of anything per pound we can easily calculate the price per quarter or half-pound. But the metric system, if carried out in its integrity, discards all save decimal fractions. As a writer in a contemporary remarks:—"The metric system in its present form brings us in contact with numbers beyond the reach of the multiplication table. The fact is that this system, as at present organised, is not so much decimal as centesimal or millesimal. In our ordinary system we can express very small quantities by whole numbers. A grain, a grain measure, a line, are quantities below which it is rarely necessary to go. The metric system requires plain, short, simple names for its various grades to be arranged in such a manner as to banish the decimal point beyond all ordinary transactions. It needs, too, names for the half, the quarter, &c., of its denominations."

Mr. JACKSON quotes the opinion of the late Warden of the Standards—"There can be no question of the greater convenience of our Weights and Measures over those of the Metric System for the practical purpose of weighing and measuring; the units have been adopted as the most convenient, and our system is far better than the metric system; but for purposes of account it is inferior to it."

The author suggests, instead of either, an English decimal system. Its units are the inch, foot, and yard, with their squares and cubes. As the standard weight he takes a cubic foot of water, which "has been a legalised standard unit of weight since the year 1859, and its legally declared value at 62° F., barometer 30", is 62.320 lbs.: taking the correct value of this unit at 32° F. as 62.4245 lbs., or 998.79 commercial ounces, its relation to the ounce of commercial weight is tolerably well established. This foot weight is the English talent, in the same way as the Greek talent was the weight of an Olympic cubic foot of water."

On this talent the author decimalises at intervals of 1000. The 1-1000th part of the talent is the scientific ounce, which differs from the commercial ounce merely by 0.12 per cent. The 1-1000th part of this ounce, the *mill*, is 0.43697 of a grain, and the 1-1000th part of the mill is the *doit* = 0.000437 of a grain. A unit of 1000 talents, the *thousand-weight*, is = 27,868 tons.

We like these short English names much better than the lengthy "classical" names of the metric scale. The author claims for his units the following advantages:—They are based on a recognised legal unit; they are transmutable into commercial units through the ounce by a reduction of 0.12 per cent; they are purely decimal; that conversion from weight to volume and from volume to weight is as practicable with them as with metric units; the actual weight of any body of known volume and density is easily ascertained. For example, the weight of 2 cubic feet of wrought iron having a specific gravity of 7.78 = 15.56 talents. The reduction of units of pressure in which these weight units are applied is as easily effected as with metric pressure units.

We commend this English scientific system to the careful examination of our readers. But whatever may be thought of this new series of units, or of the author's partial dissent from the metric system, it will be recognised that he has furnished a wonderfully complete survey of the weights and measures of all nations, ancient as well as modern. It will be found a valuable book of reference for men of the most varied pursuits. The merchant, the manufacturer, the lawyer, the statistician, the historian, the antiquary, and the divine, as well as the student of physical science, are often in need of information which they will be able to find here, and in very few other books. The chief defect we notice is the want of an index.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 16, April 17, 1882.

Transformation of Carbon Oxysulphide into Ordinary Urea and Sulphurea.—M. Berthelot.—Carbon oxysulphide and gaseous ammonia form, on combination, ammonium oxysulpho-carbamate, which is again transformable into urea by the simple elimination of sulphuretted hydrogen. This conversion is particularly distinct in presence of metallic oxides. If the aqueous solution of the salt is evaporated, there is formed a crystalline matter, formed of ordinary urea mixed with a notable quantity of sulphurea and a little ammonium sulphocyanide.

Pernitric Acid.—P. Hautefeuille and J. Chappuis.—Ozone prepared by the electrification of dry air is mixed with another gaseous compound, pernitric acid. The formation of this acid from a mixture of nitrogen and oxygen submitted to the action of the electric effluve, is limited like that of ozone, and the maximum corresponding to a given temperature may be fixed by the decrease of pressure to which the gaseous mixture is submitted. When the pernitric acid has acquired the maximum tension corresponding to the temperature of the experiment, the electric discharges decompose it into hyponitric acid and oxygen, as is shown by a sudden fall of pressure and by the deep red colouration of the gas. It is advantageous to effect the preparation of pernitric acid at low temperatures, whenever it is desired to obtain a gaseous mixture strongly charged with this acid.

Action of Ammoniacal Gas upon Ammoniacal Nitrate.—M. Raoult.—By the reaction in question there is formed a definite compound, $2\text{NH}_4\text{O.N}_2 + 3\text{NH}_3$.

Certain Reactions of the Stannous Salts.—A. Ditte.

—On pouring silver nitrate into an excess of nitrate of tin, there is produced an abundant grey precipitate, which, if washed and pressed between blotting-paper in the absence of light and dried in a vacuum, gives a grey substance, easily soluble in dilute nitric acid. It does not dissolve in ammonia, a trace of which colours it of a deep red. If the white precipitate is left in the liquid in which it has been formed it becomes red. If suspended in a large quantity of water it is transformed into a deep red powder, which, after washing and drying in a vacuum, is still insoluble in ammonia, but soluble in dilute nitric acid. It is silver meta-stannate. This compound, if heated, detonates, and is projected out of the tube. If the silver nitrate is in excess, the first drop of the tin-salt poured into it gives a pinkish white turbidity, which quickly turns red, and yields ultimately a deep red precipitate, almost black. The filtrate is at first colourless, but it quickly becomes turbid, and the same deposit is produced. The precipitate thus formed in presence of an excess of silver is, when washed and dried in a vacuum, a deep brown powder, insoluble in ammonia, but completely soluble in dilute nitric acid. It is a hydrated solution of stannous nitrate, there is formed a reddish purple precipitate, which, when washed is a deep purple mass, which is soluble both in ammonia and in dilute nitric acid. The ammoniacal solution is of a deep red; if it contains but little silver it turns colourless on exposure to the air; if it contains a notable quantity of silver it evaporates without change of colour, and leaves a purple residue, which, if air-dried, retains all the properties of the original substance, and in particular its solubility in ammonia. Platinum chloride and palladium nitrate behave like salts of silver. These deeply-coloured stannates and meta-stannates are charac-

teristic reactions for the stannous salts. They are not formed in solutions of stannic chloride.

Tetra-nitrated Ethylene Bromide.—A. Villiers.—The author has studied the direct action of nitric acid upon various bodies of the fatty series, and has succeeded in obtaining the body above mentioned, $\text{C}_2(\text{NO}_2)_4\text{Br}_2$, by thus treating ethylene bromide.

Origin of Saccharine Matter in Plants.—A. Perrey.—The author concludes that glucose is not a product of the direct elaboration of chlorophyll. Cane-sugar, on the other hand, appears to be a product of the direct elaboration of the green cells.

MISCELLANEOUS.

Official Scientific Analyst.—The President of the Royal College of Physicians of London has nominated Dr. Stevenson, of Guy's Hospital, to the post of Scientific Analyst, to conduct any analyses of bodies of deceased persons that may be ordered by the Secretary of State in the interests of Justice, during the year beginning May 1st.

South London School of Chemistry.—The prizes awarded at the examinations held on the 4th, 5th, 13th, and 15th April, were presented to the following successful competitors on Tuesday, the 27th ult.:—Chemistry, Medal, Mr. Forster; Certificate, Mr. Woollons. Botany, Medal, Mr. Woollons; Certificate, Mr. Forster. Materia Medica, Medal, Mr. Burton; Certificate, Mr. Dillon. Pharmacy—Practical Dispensing, Medal, Mr. Birbeck; Certificate, Mr. Burton. Certificates of Merit were also awarded to Messrs. Hornby, Roberts, Davies, Heald, Reade, Oldershaw, Brunton, Naylor, Capper, Wright, Tucker, and Taylor. All the candidates that presented themselves for examination during the week ending April 29th passed.

NOTES AND QUERIES.

. Our Notes and Queries column was opened for this purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Sugar in Malt.—Will any of your correspondents give me the amount of sugar in malt, either per cent or per bushel? I believe Froot gives the amount very low, and his analysis being some years ago, there may be a more recent one.—R. MARSHALL.

MEETINGS FOR THE WEEK.

- MONDAY, May 8th.—Royal Institution, 5. General Monthly Meeting. Society of Chemical Industry, 8. "The Constitution and Utilization of Sulphurous Acid," by Mr. F. Maxwell Lyte.
Society of Arts, 8. "Book Illustration: Old and New," by J. Comyns Carr.
Geographical, 8.30.
- TUESDAY, 9th.—Institute of Civil Engineers, 8.
Photographic, 8.
Royal Institution, 9. "History of Customs and Beliefs," by Dr. E. D. Tylor.
Royal Medical and Chirurgical, 8.30.
- WEDNESDAY, 10th.—Society of Arts, 8. "The Fish Supply of London," by Spencer Walpole, late H.M. Chief Inspector of Salmon Fisheries.
Geological, 8.
Microscopical, 8.
- THURSDAY, 11th.—Royal, 4.30.
Royal Society Club, 6.30.
Royal Institution, 8. "The Metals," by Prof. Dewar.
Society of Arts, 8. "The Recovery of Sulphur from Alkali Waste (Schaller's Process): a Record of Recent Results," by Alexander M. Chance.
- FRIDAY, 12th.—Royal Institution, 8. "Different Modes of Lighting," by A. G. Vernon Harcourt, at 9.
Astronomical, 8.
Quekett Microscopical Club, 8.
- SATURDAY, 13th.—Royal Institution, 5. "History of the Science of Politics," by Mr. F. Pollock.

THE CHEMICAL NEWS.

VOL. XLV. No. 1172.

SOME OF THE DANGEROUS PROPERTIES OF DUSTS.*

By F. A. ABEL, C.B., F.R.S.,
President of the Institute of Chemistry.

(Continued from p. 191.)

THE report of Faraday and Lyell was published in the *Philosophical Magazine* for January, 1845, and was followed by a letter from Faraday in the February number of the same publication, in which he referred to the lecture just delivered at the Royal Institution, and made further suggestions with respect to the method of ventilating the mines suggested in the report. But it appears that these publications remained long unknown in France, for in 1855 M. du Souich, Chief Government Mining Engineer of the Saint Etienne arrondissement, when referring to an explosion which had occurred at Firminy, advanced, as new, the view that the deposition of crusts of a light coke upon the props was due to dust which was swept up and transported to a distance by the violent current produced by the explosion, and which, being in part inflamed, would carry on and prolong the effects of the fire-damp. The fact that men near the pit's mouth received burns and other injuries, while others who were in workings near the seat of the explosion, but out of the main air current, escaped unhurt, was ascribed by him to this ignition and carriage of flame by dust. Had the results of the explosion been entirely due to the mine being highly charged with gas, the explosion must, be considered, have extended to those portions. On the occasion of two explosions in 1861, M. du Souich again dwelt upon his views regarding the part played by coal dust in increasing the disastrous effects of fire-damp explosions. In 1864-67, M. Verpilloux instituted experiments which led him to the conclusion that coal dust plays an important part in coal-mine explosions; the subject was also pursued by several other French mining engineers at about the same time, and especially by M. Vital, who made some experiments on a small scale, in 1875, in connection with an enquiry into the nature and cause of an explosion which had occurred the year before at the Campagnac Colliery, and in a part where no fire-damp had ever been detected. An examination for gas had been made by the owner, and a Mueseler shot just before a shot was fired, and after the first shot, a second shot was prepared and, the fuse having been ignited, the men retreated, when after a short interval, an explosion took place, and the men stated that they saw a body of reddish flame advancing upon them. After examining the nature of dust collected in the mine, and instituting some special experiments upon a very small scale for the purpose of ascertaining whether, and to what extent, the flame from a small charge of powder was lengthened, when projected, like the flame from a blown-out shot, into air containing fine coal dust in suspension, M. Vital concluded that very fine coal dust, very rich in volatile (inflammable) constituents, will take fire when raised by an explosion, and that portions of the coal are successively decomposed, yielding explosive mixtures with the air, whereby the fire is carried along; the intensity or violence of the burning being much influenced by the physical characters (fineness, &c.) of the dust. He also pointed out that an explosion of fire-damp, whilst taking place almost instantaneously, inflames or decomposes a

small quantity of coal dust raised thereby; explosive action being thus propagated after the fire-damp explosion has ceased. Soon after M. Vital's investigation of the subject, Mr. W. Galloway commenced a series of valuable experiments upon a larger scale, with the view of investigating the influence of coal dust in colliery explosions, and the results were communicated by him to the Royal Society in two papers in 1876 and 1879. The conclusions to which Mr. Galloway was led by the experiments described in his first paper were to the effect that a mixture of air and a particular coal dust which had been made the subject of chemical examination and practical experiment was not inflammable at the ordinary pressure and temperature, but that the presence of a very small proportion of fire-damp in the air, the existence of which could not be detected with a Davy lamp by the most experienced observer, rendered this dust inflammable, and caused it to burn freely with a red, smoky flame. From this it was inferred that an explosion, when originated in any way whatever in a dry and dusty mine, may extend itself to remote parts of the workings, where the presence of fire-damp was quite unsuspected.

In his second paper, Mr. Galloway shows that the return air of a fiery mine which, though furnishing no indication of the presence of gas when examined in the usual way (by means of a Davy safety lamp), might in his opinion contain from 2 to 2.5 per cent, may be rendered inflammable by suspending coal dust in it. He also described experiments by which it appeared to be demonstrated that the flame produced by the explosion of fire-damp in a particular part of a mine might be propagated, at any rate to some extent, by coal dust raised by the explosion and suspended in the air travelling through the mine, even in the complete absence of fire-damp in the air. The apparatus used by Mr. Galloway was constructed on a somewhat extensive scale. In connection with the channel or gallery through which a current of air, with or without coal dust in suspension was passed, was a receptacle in which a mixture of pit gas (from Liwypnia Colliery) and of air was prepared and exploded. The direct communication between the gas vessel and the gallery (representing a mine way) was only interrupted by a diaphragm composed of from 2 to 6 leaves of newspaper; this separator being burst through by the explosion of a mixture of nearly two cubic feet of fire-damp with the requisite proportion of air. The coal dust was placed on the floor of the gallery and upon certain shelves fixed in it. It appeared open to question whether, with the employment of this apparatus there was not a possibility of very small quantities of fire-damp penetrating, before the explosion, into the gallery from the explosive chamber, through the closing arrangement above alluded to, and whether the results obtained in the gallery might, consequently, be accepted as produced solely by the effect of the concussion produced and flame promoted by the gas explosion in the separate chamber.

In a paper just communicated to the Royal Society, Mr. Galloway argues that any amount of gas which may thus escape into the gallery must be altogether insignificant as regards any possible influence upon the results obtained.

The conclusion now arrived at by Mr. Galloway, as the result of continued experiments with this apparatus, of which he has just given a further account, and of his examination into the effects produced by the Penygraig explosion in December, 1880, and the Risca and Seaham explosions of that year, is confirmatory of that published by him last year, namely, that the very decided view which he first held, "that a mixture of air and coal-dust is not inflammable at ordinary pressure and temperature without the presence of a small proportion of fire-damp," has not been borne out by his further experiments, as he considers that he has now shown "conclusively that fire-damp is altogether unnecessary for the propagation of flame with explosive effects by a mixture of coal-dust and air," when the scale on which the experiments are made is large enough, and when the fineness and dryness of the dust are "unquestionable."

* A Lecture delivered at the Royal Institution of Great Britain, Friday, April 26, 1882.

This conclusion coincides in the main with that arrived at in 1878, as the result of experiments by Prof. Freire Marreco, conducted in connection with the North of England Institute of Mining and Mechanical Engineers, which Society, as well as the Chesterfield and Derbyshire Institute of Engineers, has laboured very usefully in this direction contemporaneously with Mr. Galloway. The most recent conclusions of the latter in respect to coal-dust were in fact forestalled by those which the late lamented Prof. Marreco, in association with Mr. P. D. Morison, communicated to the first-named Institute in November, 1878, and which were published in its *Transactions* of that date.

Messrs. Marreco and Morison's experiments were carried out in galleries or long boxes, representing mine workings, though on a smaller scale than Mr. Galloway's later apparatus, and conducted somewhat differently in their details. The apparatus used by them at Harton Colliery (and with which experiments have since been continued by Messrs. Lindsay Wood and G. May) was in fact a double gallery, so arranged that the air current which passed into one gallery made its exit at the end of the second, alongside the point of its first entrance. The mode of proceeding was to fire successively two powder shots, in different positions in the gallery box, from small cannon, so as to represent blown-out shots in the effects produced; coal-dust was placed upon the floor of the box, and one shot was first fired against the air current which was passing at a known velocity. The dust-cloud thereby raised was carried along by the current, and a second shot was fired into it, and in a large number of experiments made with many different descriptions of dust, the flame produced by the second shot was increased by that of inflamed dust, a comparatively clear flame being sometimes produced, while in other instances it was accompanied by a shower of sparks. The view taken by Vital, Marreco, and others, regarding the action of coal-dust in propagating flame in air free from fire-damp, is to the effect that the first portions of dust acted upon by the inflamed gases of the shot liberate inflammable gas which mixes with the air, and is fired, the non-volatile part of the coal being in part consumed and in part deposited as a feeble coke. Some examination of coked deposits of dust sent to Marreco subsequently by Mr. Galloway confirmed the observations originally made by Faraday and Lyell, that the coal-dust is in part submitted to destructive distillation during the progress of the flame through the dust-laden air. Marreco considers that, although a proportion of the heat developed by the burning dust is absorbed by the gasification of the coal-constituents, the heat of combustion of these suffices to leave a margin for the carrying on of the action from one particle of dust to another, provided these be in sufficiently close proximity to each other.

In the experiments made by the Chesterfield and Derbyshire Institute of Engineers, in a very long gallery, results were obtained very similar to those of Marreco and Morison, and it was also found that a lengthening of a gas flame, which was placed in the gallery, could be obtained by causing the current of air to carry with it thick clouds of some descriptions of coal-dust.

Many instances are on record in this country and others of the firing, with semi-explosive violence, of clouds of coal-dust, produced either in the open air or in localities where no fire-damp could exist, some portions of the mixture of dust and air having come into contact with a flame or fire. Thus Marreco and Morison mention a case of a considerable quantity of coal-dust, which had been accidentally thrown over some screens at a pit's mouth, flashing into flame as the dust-cloud came into contact with a neighbouring fire, and burning a man very severely; and another accident, which occurred in a stone-drift, where it was believed that no gas could possibly be present. A considerable body of rock was dislodged and coal-dust raised by the firing of a shot, the flame of which fired the air and dust mixture, with very mischievous results. From 50,000 to 60,000 cubic feet of fresh air were

said to be passing through the drift per minute when this accident occurred.

There appear good grounds for believing that, provided coal-dust be sufficiently fine and thickly suspended in the air, and of a readily inflammable nature, fire may travel to a considerable distance in the working of a mine, through its agency, in the complete absence of fire-damp. The effects of transmission of flame in this way would be decidedly different, and much inferior in violence, to those produced by an explosion of fire-damp and air, or of a mixture of these with coal-dust; the comparative suddenness of the gas explosion would produce greater destruction and less burning effects than the comparatively gradual explosion, or the rapid burning of a dust and air mixture. In the latter case, the coal-dust will generally be considerably in excess of the air needed for its combustion, so that, however finely divided, much will escape being burned, and may be only very partially coked; and it is conceivable that, as suggested by Mr. Galloway, a second rapid burning or semi-explosion may be caused by the inrush of air, following the first explosion, into the workings which may be thick with heated and only partially burned dust, some of which may still be incandescent.

Considering that, since first Faraday and Lyell directed attention to the dangers of coal-dust in mines, its behaviour has been made the subject of many series of experiments and published reports here and abroad, it is remarkable that in most instances of coal-mine explosions, until quite recently, the probable effect of coal-dust in increasing their magnitude does not appear to have received the serious attention which it merits at the hands of mine-owners and of those in authority connected with coal-mines. When the Royal Commission on Accidents in Mines was appointed, it collected evidence from H.M. inspectors of mines, from experienced colliery owners and mining engineers, and from selected pitmen, with respect to the causes of accidents, and that evidence included several statements regarding the possible influence of coal-dust in aggravating explosions, but the preponderance of opinion of H.M. inspectors was against the view that explosions could originate with, or be to any great extent propagated by, coal-dust in the absence of fire-damp. The only experiment on a practical scale bearing upon the subject which appears to have been made until quite recently is that of Mr. H. Hall, Mine Inspector of the North Wales, &c., District, who, in firing charges of 4 lbs. of powder from a cannon in an adit driven about 50 yards from the surface in a coal seam on the dip, coal-dust being sprinkled upon the floor, obtained flame extending to distances of 30 to 60 yards, while without the dust the flame of the shot did not extend more than 6 or 7 yards.* Some decided opinions were expressed that the supposed influence of coal-dust in aggravating explosions was over-rated, and that it would certainly not lead to explosions in the absence of gas. On the other hand, Mr. Galloway expressed a strong opinion that some of the most extensive of recent explosions, such as those at Llan and Abercarn, were at any rate largely contributed to by coal-dust, and more recently—on the occasion of the inquiry into the Penygraig explosion—he gave evidence to the effect that the disastrous results of this explosion were mainly, if not entirely, ascribable to the action of coal-dust, supporting this opinion by the results of a minute examination into the condition of the pit, of the sufferers, &c., after the accident.

When the terrible calamity which occurred at Seaham Colliery in September, 1880, was officially enquired into, the suggestion was very decidedly put forward by the miners' representatives, that the coal-dust which existed in large quantities in some parts of the mine, and especially near the spot where it was surmised that the explosion had originated, might have had much to do with the accident. Indeed the opinion was strongly entertained

* Mr. Hall stated that the air in this adit was "practically" free from gas, but did not maintain its absolute freedom.

by some that it was entirely due to the ignition of coal-dust, in the absence of gas, by the flame from a blown-out shot. The lecturer was consequently requested by the Home Secretary to make experiments with samples of dust collected in different parts of the mine, and the results obtained with them led to an extension of experiments with dust from other collieries in different parts of the kingdom. These experiments, carried to a certain point for the immediate purpose of the Seaham enquiry, have been interrupted for some time, but the Royal Commission has now resumed them with the object of obtaining more precise data in connection with certain results which were elicited by the first part of the investigation.

The earlier experiments were carried on at the Garswood Hall Colliery, where a constant and abundant supply of pit-gas (a so-called blower) is brought to the surface, and was kindly placed at the service of the Commission by Messrs. Smethurst and Co., together with many conveniences for the purposes of these and other important experiments upon which they have been engaged. The apparatus used at Garswood for the experiments with the Seaham and other dusts, was similar in character to those employed by Freire Marreco, Galloway, and others, great pains being taken to secure accuracy and uniformity in the velocity of the air currents passing through the gallery, in the proportion of pit-gas, or fire-damp, used with the air, and in the intimacy of the mixture. In order to raise the air-current in the gallery to a temperature similar to that of the atmosphere in colliery workings, the air supply was drawn through a system of heated pipes, so that, when passing at as high a velocity as 1000 feet per minute, its temperature would be raised up to 80° or 85° F. even in the very severe weather during which some of these experiments were made.

The samples of coal-dust experimented with were examined with respect to fineness, proportions of volatile matter and ash, and one or two other points, and they were all carefully dried before use.

Experiments were made in the first instance with a view of ascertaining the smallest proportion of fire-damp which, when mixed with the air passing through the apparatus, would furnish an atmosphere capable of firing at a naked flame of a particular size, placed in the gallery. It was next ascertained what quantity of gas below that proportion was needed to impart to the mixture of air with a large quantity of each particular coal-dust the property of exploding throughout the gallery. By these experiments the samples were classed in the order of their sensitiveness to explosion, and it was found that those which were very rich in pure coal, and which contained the highest proportion of very fine dust were the most sensitive, i.e., required the lowest proportions of fire-damp in air to bring them to explode readily when suspended in a dense cloud. But with the samples containing larger proportions of non-combustible matter the order of sensitiveness did not necessarily harmonise with the comparative richness of a sample in pure coal, nor with its comparative fineness, and this was strikingly illustrated by a sample of dust from one of the roads in Seaham Colliery, which contained more than half its weight of non-combustible matter, yet ranked only third in order of sensitiveness, while another sample, containing considerably more coal and a somewhat larger proportion of the finer dust, ranked fifth.

Another point clearly established, and confirming by more accurate data the observations of earlier experiments, was that the proportion of fire-damp required in a mine to bring dust into operation as a readily exploding material when thickly suspended in the air is bordering upon and even below the smallest amount which can be detected in the atmosphere of a mine, by the most practised observer, with the use of the Davy lamp, the only means of searching for gas which has until quite recently been employed in mines. The highest proportion which can thus be detected by an experienced operator is stated to be about 2 per cent.

Explosions were produced by dusts suspended in air travelling at a velocity of 600 feet per minute, when fire-damp was present in proportions ranging from 2 to 2.75 per cent; in currents of low velocity the same result was produced with a sensitive dust in the presence of only 1.5 per cent of fire-damp, and ignitions which approached explosions in their nature and extended to considerable distances, were obtained with this dust in air containing still smaller proportions of gas. Mixtures of fire-damp and air bordering upon those which will ignite upon the approach of flame, were found to be instantaneously fired by a lamp if they contained only a few particles of dust in suspension; and in connection with this fact the interesting observation was made that such dust particles need not be inflammable nor combustible to produce the result named. Mixtures of air and gas which passed a naked flame without any symptom of ignition were inflamed when particles of a fine light powder, such as calcined magnesia, were suspended in them. The action of certain of the pit-dusts which contain comparatively little coal, in determining the ignition of mixtures of air and small proportions of fire-damp, is possibly of the same character as the behaviour of such a dust as calcined magnesia. The power of favouring the ignition of mixtures of fire-damp and air was not exhibited by some other powders similar in fineness to the latter, but differing in structure and density from this and one or two other non-combustible dusts which may be called alive; and even different samples of magnesia, differing somewhat in lightness from each other, appeared to possess the activity in different degrees. These facts seem to favour the view that a dust possessing particular physical characteristics exerts a contact or catalytic action upon gas mixtures, similar to that known to be possessed by platinum and some other substances under particular conditions. Thus, when finely-divided platinum, or even a clean recently-heated surface of the compact metal is brought into contact with mixtures of hydrogen, or of a hydrocarbon gas or vapour, with oxygen or air, oxidation of the hydrogen or hydrocarbon is at once established, accompanied by the development of heat, whereby the temperature of the metal is raised and chemical activity promoted, so that heat speedily accumulates, raising the metal to a temperature sufficiently high to bring the surrounding gas-mixture to the exploding point. If the metal presents a very large surface, or is in a specially porous condition, as in the form of sponge or very fine powder (platinum black), the explosion of the gas-mixture may follow very rapidly, or almost instantly, upon the first contact of some portion with it.*

In many of the experiments with calcined magnesia just referred to, it was distinctly noticed that a dark space intervened between the gas-flame used as the source of heat and the flare produced by the ignition of the gas-mixture through the influence of the dust cloud suspended in it, which would seem to indicate that the dust particles, immediately upon passing through the flame, established some amount of oxidation of the fire-damp, which proceeded with increased rapidity as the dust became more highly heated through the chemical action developed, so that within a short distance from the point where the heating commenced the dust became incandescent, and the ignition of the gas-mixture followed. Further experiments which are contemplated may elucidate the precise nature of this action of non-combustible dust in promoting the ignition of gas-mixtures which, in the absence of dust, are not inflammable. There appears little doubt, however, that it constitutes one element in the dangers arising from the presence of dust in the air of a mine which con-

* This action of platinum (or palladium) has recently received applications bearing special reference to the existence of explosive gas mixtures in coal-mines. The one consists in an apparatus proposed by Mr. Körner for removing, by slow combustion, local accumulations of fire-damp; the other is a very simple and portable photometric apparatus, devised by Mr. G. H. Liveng, by which proportions of fire-damp much lower than the smallest amount discoverable by the Davy lamp in the hands of the most expert, can be readily and quickly detected, and the amount estimated with considerable accuracy.

tains a small proportion of fire-damp, and in which a large body of flame is accidentally produced, either by a blown-out shot, or by a fire-damp explosion of local character.
(To be continued.)

ON THE SPECIFIC RESISTANCE OF MERCURY.*

By LORD RAYLEIGH, F.R.S., Professor of Experimental Physics in the University of Cambridge, and MRS. SIDGWICK.

THE observations detailed in the paper were made with the view of re-determining the relation between the B.A. unit and the mercury unit of Siemens, i.e., the resistance of a column of mercury at 0°, one metre in length, and one square millim. in section.

According to Siemens,

1 mercury unit = 0.9536 B.A. units,

and according to Matthiessen and Hockin,

1 mercury unit = 0.9619 B.A. units.

The value resulting from our observations agrees pretty closely with that of Siemens. We find

1 mercury unit = 0.95418 B.A. units.

Four tubes were used to contain the mercury, of lengths varying from 87 to 194 centims. The diameter of the three first tubes was about 1 millim. and that of the fourth about 2 millims. The final numbers obtained from the several fillings of the tubes are as follows:—

| | | |
|--------------|-----------|---------|
| Tube I. .. | { 0.95386 | 0.95416 |
| | { 0.95412 | |
| | { 0.95424 | |
| | { 0.95436 | |
| Tube II. .. | { 0.95421 | 0.95419 |
| | { 0.95389 | |
| | { 0.95414 | |
| | { 0.95437 | |
| Tube III. .. | { 0.95436 | 0.95416 |
| | { 0.95424 | |
| | { 0.95418 | |
| | { 0.95399 | |
| Tube IV. .. | { 0.95425 | 0.95427 |
| | { 0.95440 | |
| | { 0.95413 | |
| | { 0.95413 | |

Combining the results of the present paper with our determination of the B.A. unit in absolute measure we get

1 mercury unit = 0.954130 × 10⁸ C.G.S.

THE WATER SUPPLY OF THE CITY OF NEW YORK.†

By E. WALLER, Ph.D.

I DESIRE in the first place to present the results of complete analyses of the Croton water made at different times. The various denominations of salts present have been given, in order to more literally quote the different analysts. For the three first analyses double columns representing the results in grains per English Imperial gallon of 70,000 grains and in grains per United States gallon of 58,318 grains, the first columns in each case being the form in which the analysts have recorded their results to judge from the context. In Nos. 4 and 5 the magnesium and calcium bicarbonates have been calculated back to mono-carbonates, and the results given in brackets.

* Abstract of a Paper read before the Royal Society, May 4th, 1882.

† Paper read before the American Chemical Society, Feb., 1884.

Another table of the same results calculated to parts per 100,000 is appended.

There is probably less difference in the constituents of the water than the figures would seem to indicate, the mode of stating the results in the earlier analyses rather suggesting different modes of conducting the examination, and calculating results to those at present in use.

Next permit me to call your attention to a chart showing graphically the variations found in the constitution of the Croton water, by Dr. Chandler, during the summer months of 1867 and 1868, representing some fifty examinations, and my own results made in a similar manner from the latter part of 1872 to the middle of 1879, representing about 350 examinations. The average results may be thus stated:—

Average of Results on Croton Water in Parts per 100,000.

| | Mineral Matter. | Organic and Volatile Solids. | Total Solids. | Hardness. | Oxygen required. |
|---|-----------------|------------------------------|---------------|-----------|------------------|
| Summer of 1867 | 6.72 | 1.12 | 7.84 | 4.32 | 0.181 |
| " " 1868 | 5.66 | 1.97 | 7.63 | — | 0.168 |
| Last 2 mos. 1872 | 7.48 | 0.44 | 7.92 | 3.553 | 0.131 |
| Year 1873 | 6.23 | 1.59 | 7.82 | 3.395 | 0.135 |
| " 1874 | 5.83 | 1.76 | 7.59 | 3.332 | 0.166 |
| " 1875 | 5.656 | 1.835 | 7.491 | 3.293 | 0.211 |
| " 1876 | 5.416 | 1.682 | 7.098 | 3.159 | 0.185 |
| " 1877 | 5.603 | 1.823 | 7.426 | 3.260 | 0.253 |
| " 1878 | 5.299 | 1.904 | 7.203 | 2.846 | 0.183 |
| First 5 mos. 1879 | 5.424 | 0.912 | 6.336 | 2.811 | 0.072 |
| Average from Nov., 1872, to May, 1879, inclusive— | 5.702 | 1.678 | 7.380 | 3.210 | 0.180 |

The "Total Solids" were determined by weighing the residue obtained by evaporating a measured quantity; the "Organic and Volatile" by igniting the residue, moistening with carbon dioxide water, drying, and weighing again; the "Hardness" by soap solution as usual, the results being expressed in the equivalent of grains of calcium carbonate, while the permanganate test employed was that so frequently used,—acidification of a measured quantity of the water by sulphuric acid, and adding standardised solution of potassium permanganate until the colour held for half an hour, the water being kept during the test at the ordinary temperature of the laboratory.

In addition to these several other examinations made at irregular intervals at other times than those specified above, might be quoted, but as they present no marked deviations from those quoted, I will not occupy your time with them.

As a sample of similar determinations made on samples of the Croton taken from different parts of the City at the same time, I would present the results obtained in the latter part of April of last year, when the odours in the water caused the suspicion that it contained some compounds dangerous to health.

| | Mineral Matter. | Organic and Volatile. | Total Solids. | Oxygen absorbed. (Permanganate). |
|---------------------------|-----------------|-----------------------|---------------|----------------------------------|
| No. 1. West 33rd St. . . | 6.6 | 2.2 | 8.8 | 0.064 |
| No. 2. East 34th St. . . | 6.0 | 1.5 | 7.5 | 0.060 F |
| No. 5. West 131st St. . . | 4.4 | 1.3 | 5.7 | 0.064 F |
| No. 8. East 122nd St. . . | 5.7 | trace | 5.7 | 0.062 |

The samples marked F were clarified by subsidence or filtration before examination, as they contained varying amounts of muddy sediment, and were therefore not fair samples of the water as ordinarily used. It may be mentioned that about a pint of No. 5, on standing about half an hour in a cylinder 2½ inches in diameter, deposited a sediment of about ¼ of an inch in depth. When this sediment was distributed as evenly as possible through the water, and a portion examined, the results were:—

| | Mineral Matter. | Organic and Volatile. | Total Solids. | Oxygen absorbed. (Permanganate). |
|--------|-----------------|-----------------------|---------------|----------------------------------|
| No. 2. | 7.57 | 21.0 | 96.70 | 0.366 |
| No. 5. | 69.2 | 15.1 | 84.30 | 0.455 |

A portion of the sediment was examined separately; shaken with ether it afforded, as soluble in that menstruum, a minute proportion of vegetable wax, having a slight greenish brown tinge, probably from the presence of chlorophyll. A small amount was obtained for analysis, the results being:—

| | Per cent. | Per cent. |
|-------------------------------------|---------------------------|-----------|
| Loss on ignition .. | 23.31 | |
| Silica | 43.61 to 51.0 | |
| Lime | 0.63 = CaCO_3 .. | 1.12 |
| Magnesia | 3.16 = MgCO_3 .. | 6.64 |
| Ferric and aluminic oxides | 20.92 | |

As to other determinations on the Croton water, the following results may be offered (parts per 100,000):—

| Date. | Free Ammonia. | Albumenoid Ammonia. | Remarks. |
|-----------------------|---------------|---------------------|---|
| August, 1874 | 0.00095 | 0.0145 | Average of 6 |
| Dec., 1877 | 0.001 | 0.0102 | " " 2 |
| Nov. 16, 1878 | 0.0015 | 0.0130 | |
| July 11, 1879 | 0.0008 | 0.008 | |
| April 4, 1881 | 0.0020 | 0.0110 | |
| " 22, " | 0.0016 | 0.0117 | " " 10 |
| " 22, " | | 0.010 to 0.031 | Total NH_3 on very turbid samples. |
| May 16, 1881 | 0.001 | 0.007 | |
| Nov. 8, 1881 | 0.002 | 0.012 | |
| Nitrogen in Nitrates. | | | |
| July 29, 1881 | | 0.0198 | |
| Nov. 8, 1881 | | 0.0181 | |

The results obtained on free and albumenoid ammonia do not indicate any material alterations in the proportions of those constituents for yielding nitrogen in those forms. The examination of last April shows that the quality of the water does not vary extensively in different parts of the city at the same time, unless the sediment is mixed in when the amount of nitrogen obtainable as ammonia by distillation may reach nearly thrice the amount obtainable from the sample when fairly clear. The amounts of nitrogen in nitrates, so far as they go, give no indications of sewage contamination in the water.

About the end of last year a paper by Prof. Leeds on "The Relative Purity of City Waters in the United States," was published in the *CHEMICAL NEWS*, vol. xlv., p. 265, in which the Croton water was condemned as polluted. The analytical results were given as follows:—

Croton, June 23, 1881. Results in Parts per 100,000.

| | |
|-------------------------|--------|
| Free ammonia .. | 0.0027 |
| Albumenoid .. | 0.027 |
| Oxygen required .. | 0.81 |
| Nitrates .. | none |
| Nitrites .. | 0.8325 |
| Chlorine .. | 0.350 |
| Hardness .. | 3.30 |
| Total solids .. | 11.80 |
| Mineral matter .. | 5.00 |
| Organic and volatile .. | 6.80 |

These results I strenuously object to, first, because they are misleading. The term nitrates is indefinite, and when so many chemists calculate their results to nitrogen in nitrates, &c., the impression might readily be created that nitrogen in nitrates is meant by the above figure for nitrates. The "Oxygen required," as I have learned, was obtained by Kubel's method,—by reaction of potassium permanganate on the water strongly acidified with sulphuric acid at boiling heat. Inasmuch as most chemists (at least in English-speaking countries) make use of the permanganate test at ordinary temperatures, such a statement as the above without specifying the method used is calculated to convey a false impression of the quality of the water. Moreover, the test performed in that way is open to serious objection. Under those circumstances the

chlorine in the water would affect the results, and Prof. Leeds himself has shown us that the reagents used invariably contain impurities which would affect the test to the prejudice of the water tested, the permanganate containing chlorine compounds, and the sulphuric acid (which is used in considerable amounts proportionately) also containing nitrogen compounds, sulphurous acid, &c., and where a line is drawn on comparatively small amounts, the impurities of the reagents would make a great difference in the conclusions drawn.

Prof. Leeds's results on total solids and free and albumenoid ammonia are very high—indeed, higher than any results I have obtained during the past fourteen years, except when (as last spring) the samples of water were so charged with sediment as to render them by no means fair samples of the Croton water as ordinarily obtainable. The conclusion would seem to be that his sample was turbid with sediment. With regard to other determinations, they either agree with preceding examinations, or the methods employed were different from those of which I made use, and therefore preclude a comparison between them.

In commenting on the results, Prof. Leeds remarks: "New York and all the places mentioned lower on the list receive their water from contaminated sources. The feeders which empty into Croton Lake, the principal reservoir of the New York water, pass through a settled country, with numerous tanneries, factories, &c., along their banks. Analyses of the Croton water made at different times during the past five years, have shown that it is to be classed among contaminated water supplies." A quotation of this statement was sent to Mr. Isaac Newton, Chief Engineer of the Croton Aqueduct Depot. His reply was briefly to the effect that he had comparatively recently examined the Croton watershed, and that Prof. Leeds's assertion with regard to it was altogether erroneous. From other sources I have been able to ascertain, first, with regard to the population of the watershed, that for its area of 339 square miles the population is from 17,000 to 20,000, or about one man to every ten acres. Permit me to quote the table given by Mr. D. M. Greene, given in the "Twenty-third Annual Report of Water Commissioners of the City of Troy, for 1877," p. 120.

Population of Watersheds for Water Supplies of Cities.

| City. | Pop. per Sq. Mile. |
|---|--------------------|
| Rochester, N.Y. .. | 36 |
| New York, N.Y. .. | 65 |
| Albany, N.Y. .. | 77 |
| Poughkeepsie, N.Y. .. | 86 |
| Schenectady, Cohoes, and West Troy, N.Y. (Supply from Mohawk River) .. | 103 |
| Brooklyn, N.Y. .. | 119 |
| Boston, Mass. .. | 229 |
| London, England .. | 270 |

Second, as regards industries in the Croton watershed. But few tanneries now exist in that region, for the simple reason that the most of the trees yielding the necessary bark have been cut down, and tanning is no longer profitable at that locality. As regards other industries the region contains but few factories of any kind, and those are on a small scale.

To sum up, then, I desire to express a most emphatic dissent from Prof. Leeds's conclusions, for the following reasons:—1. The proportion of chlorides existing in the water has not increased of late years, so far as the records extend, and hence no indications of contamination by sewage or manufactures can be asserted to exist. 2. The amounts of oxygen absorbed, by permanganate test for a number of years, serving to give a comparison of the quality of the water with itself at different times, show no changes in the quality of the water. The same may be said for the results on free and albumenoid ammonia and organic and volatile matter. 3. The Croton watershed is not crowded either with population or with

COMPLETE ANALYSES OF CROTON WATER.

| Number— | 1. | 2. | 3. | 4. | 5. | 6. | 7. |
|---------------------------------|--------------------|--------------------|---------------|--|---|---|---|
| Analyst— | Prof. J. C. Booth. | Dr. J. R. Chilton. | | C. F. Chandler. | | E. Waller. | |
| Date— | 1843. | 1843. | August, 1859. | Summer, 1859. | Summer, 1859. | May, 1879. | Nov. 1881. |
| Gallon used— | Eng. U.S. | Eng. U.S. | Eng. U.S. | Gallon 2169. 2169. 2169. 2169. 2169. 2169. 2169. 2169. | U.S. Gallon 2169. 2169. 2169. 2169. 2169. 2169. 2169. 2169. | U.S. Gallon 2169. 2169. 2169. 2169. 2169. 2169. 2169. 2169. | U.S. Gallon 2169. 2169. 2169. 2169. 2169. 2169. 2169. 2169. |
| Sodium chloride | | | | | | | |
| Calcium sulphate | | | | | | | |
| Alkaline chlorides | 0.193 | 0.161 | | | | | |
| Potassium sulphate | | | | | | | |
| Sodium sulphate | | | | | | | |
| Alkaline carbonates | 0.828 | 0.690 | | | | | |
| Magnesium chloride | | | | | | | |
| Calcium chloride | | | | | | | |
| Magnesium carbonate | 0.939 | 0.782 | | | | | |
| Calcium carbonate | 2.293 | 1.910 | | | | | |
| Magnesium bicarbonate | | | | | | | |
| Calcium bicarbonate | | | | | | | |
| Ferric and aluminic oxide | 0.110 | 0.092 | | | | | |
| Silica | 0.359 | 0.299 | | | | | |
| Organic and volatile | 0.276 | 0.240 | | | | | |
| Total solids | | | | | | | |
| Solids by evaporation | 4.998 | 4.174 | | | | | |
| Chlorine | | | | | | | |

Nos. 1 and 2. "Illustrations of the Croton Aqueduct, F. B. Tower, N.Y.," 1843, p. 135. No. 3. "Report of Water Commissioners of Albany for 1865," p. 50. Nos. 4 and 5. "Report of New York Board of Health for 1871," p. 371. No. 6. "Report on Croton Water, New York, 1881," p. 45.

COMPLETE ANALYSES OF CROTON WATER. RESULTS IN PARTS PER 100,000.

| Number— | 1. | 2. | 3. | 4. | 5. | 6. | 7. |
|----------------------------------|--------------|----------------|------------|-----------------|------------|------------|-------------|
| Analyst— | J. C. Booth. | J. R. Chilton. | | C. F. Chandler. | | E. Waller. | |
| Date— | 1843. | 1843. | Aug. 1859. | Summer, 1859. | May, 1872. | May, 1879. | Nov., 1881. |
| Sodium chloride | | | | | | | |
| Calcium sulphate | | | | | | | |
| Alkaline chlorides | 0.276 | | | | | | |
| Potassium sulphate | | | | | | | |
| Sodium sulphate | | | | | | | |
| Alkaline carbonates | 1.183 | | | | | | |
| Magnesium chloride | | | | | | | |
| Calcium chloride | | | | | | | |
| Magnesium carbonate | 1.341 | | | | | | |
| Calcium carbonate | 3.276 | | | | | | |
| Magnesium bicarbonate | | | | | | | |
| Calcium bicarbonate | | | | | | | |
| Ferric and aluminic oxides | 0.157 | | | | | | |
| Silica | 0.513 | | | | | | |
| Organic and volatile | 0.394 | | | | | | |
| Total | | | | | | | |
| Solids by evaporation | 7.140 | | | | | | |
| Chlorine | | | | | | | |

manufactures, as Prof. Leeds seems to imagine. 4. The health of the community is not and has never been such as to indicate the presence of any contamination in the water supply.

During the evening a ballot was held: Messrs. Groves and Makins were appointed scrutineers. The following gentlemen were declared to be duly elected Fellows of the Society:—L. W. Andrews, J. H. Beckett, J. H. Bicket, B. A. Burrell, J. Falkner, G. R. Faulkner, W. J. Kemp, S. Langdon, E. G. Love, A. F. Price, W. H. A. Peake, A. N. Palmer, J. Robinson, S. P. Sadler, W. C. Samuel, J. H. Smith, J. H. Stebbins, P. W. Squire, L. Taylor, G. Watson.

The President then called on Prof. DEWAR, F.R.S., to deliver his lecture "On Recent Developments of the Theory of Dissociation."

The lecturer said the title of the lecture was too extensive a one to be applied to his discourse, as he intended to describe a few only of the more important discoveries in this field of research. On a former occasion he had addressed the Society on the same subject, principally on the work of Deville. Since then mathematicians, by the aid of thermo-dynamical laws, had rendered the chemist a great service by systematising and classifying the phenomena, the discovery of which the world of science will

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 4, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

THE minutes of the previous meeting were read and confirmed.

The following certificates were read for the first time:—R. Alexander, G. J. Ellis, D. E. Johnstone, T. W. Lovibond, R. W. Pullar.

always associate with the name of Deville. The first chemist who studied chemical action as analogous to a physical change of state was Black. He had a great objection to hypothesis, and instead of calling his course Lectures on Chemistry, he designated them Lectures on the Effect of Heat and Mixture. Deville used the term dissociation to express chemical decomposition subject to certain conditions. A compound substance is said to be dissociated when the operation of decomposition is subject to the conditions—that the products of decomposition remain within the sphere of chemical action; and that the operation is reversible, in the thermo-dynamic sense of the term. The lecturer illustrated the phenomena of dissociation by showing the partial decomposition of iodide of mercury as the temperature increased, and the varying partial pressure of the ammonia evolved from the chloride of calcium compound. The stability of a body depends upon the temperature and pressure of the environment, where the medium in which the substance is placed is assumed to consist in part, of at least one of the gases produced by the dissociation of the compound.

Troost made experiments with calcium carbonate, and proved that the pressure of the CO_2 evolved is a function of the temperature, and is completely independent of the mass of lime or of calcium carbonate. When calcium carbonate is decomposed by heat we have to consider the effects of three bodies, carbon dioxide, calcium oxide, and undecomposed calcium carbonate. Now Troost proved three points:—(1) That the decomposition was a function of the temperature; (2) that the decomposition was independent of mass; (3) that the action is reversible, i.e., the moment the temperature is lowered the partial pressure is also altered and re-combination takes place, so that the process resembles the condensation and volatilisation of a vapour. Deville proved that the temperature of the oxy-hydrogen flame was far below that indicated by theory, and he showed in the case of the flame of CO and O that the composition of the flame varied at different parts, so that in the hottest part there was most free oxygen. Deville also pointed out that experiments in which vapours were conducted along heated porous tubes, and so subjected to diffusion whilst dissociated, were only of value for showing that a certain amount of dissociation had taken place, and were valueless for determining the percentage amount of the dissociation. It was therefore impossible by such means to decide whether the substances were completely broken up or not.

The first exact determinations of partial pressures at various temperatures we owe to Isambert, who used the ammonio-chlorides of calcium and of silver. When these substances are heated, the partial pressure of the ammonia comes to a definite and fixed point for each temperature, if sufficient time be given to reach equilibrium. By numerous determinations a series of curves is obtained, showing the partial pressures at any temperature. Diagrams of such curves were exhibited, showing the curves of ammonio-chloride of silver, the ammonio-chloride of calcium, water, hydrogenium, &c. These curves all exhibit a different rate of increase as the temperature rises. As the temperature is raised the ratio of the increment of the pressure to the temperature becomes greater, until the curves become almost vertical. From such a table we can learn by inspection the pressure required to preserve any substance in a stable condition at any temperature. These bodies apparently follow a law similar to that of saturated vapours, but the true law is probably more complicated.

Recent investigations have shown that at a certain temperature chemical compounds behave like liquids and gases at the critical point. Thus if sulphuretted hydrogen and water be subjected to pressure, at low temperatures, a solid crystalline hydrate is formed; but if the temperature be kept at 40°C . no solid hydrate can be shown to exist, however great the pressure may be. Similar phenomena are observed with hydrochloric acid gas and phosphamine.

The lecturer then had shown on the screen two capillary

tubes, containing respectively hydrogen sulphide and water, and hydrochloric acid and phosphamine. To take the first of these mixtures: on applying pressure by means of a pump, similar to that used in Cailliet's apparatus, the hydrogen sulphide was first liquefied, and the water and the liquefied gas were seen one above the other: on increasing the pressure dark specks of the crystalline hydrate were seen; these gradually increased, until the whole tube became opaque. On decreasing the pressure these solid particles disappeared, and the tube became transparent. The experiment was repeated, with the tube surrounded with water at 40°C .; no solid hydrate was formed, although the pressure, as indicated by the gauge, amounted to 200 atmospheres.

Another experiment was here shown. Two transparent crystals of calcite were placed in two platinum crucibles raised just above the melting-point of zinc: through one crucible a current of carbon dioxide was passed, the other was exposed to the atmosphere; after some time it was seen that the crystal in the carbon dioxide remained transparent, the other had become partially converted into lime.

In the next experiment a current of hydrogen was passed over a bulb containing iodine gently heated; the mixed elements then passed through a coil of metal tubing heated to 250° to 300°C ., and a continuous formation of hydriodic acid was observed. If, on the other hand, hydriodic acid had been subjected to this temperature, it would have been partially decomposed into hydrogen and iodine. So that at the same temperature hydriodic acid may be both formed and decomposed. The action is reversible, and resembles the condensable state of a vapour. Moreover, in both cases—i.e., whether a mixture of the elements or the compound be employed—the resulting mixtures of hydrogen, iodine, and hydriodic acid will be identical in composition, provided the temperature and pressure are the same, the combination or decomposition proceeding until an equilibrium is established.

The cycle of Carnot was explained, and Clapeyron's formula—applicable to all substances undergoing change of state at a constant temperature and pressure—deduced. The most convenient form of the equation is as follows ("Theory of Heat," Clerk Maxwell, Cap. VIII., On Heat Engines):—

$$\text{Molecular latent heat} = LD = \frac{T_2}{p} \frac{dp}{dt}$$

when the substance is transformed into the gaseous state at temperatures considerably below its critical point. By means of this formula the latent heat of volatilisation can be calculated. This is often of advantage to the chemist, as the accurate determination of latent heat is difficult. In order to test the application of this formula to dissociation phenomena, the amount of heat evolved or absorbed in the change (which in this case is called Heat of Combination) has to be calculated from the equation, by replacing the ratio of increment of pressure and temperature of the saturated vapour by a similar ratio deduced from the values of the tensions of dissociation for different temperatures. It is assumed that the transformation takes place at a temperature and pressure when the volume of the gas produced by the dissociation is very great in comparison with the volume of the non-volatile solid substance. When the formula is applied to carbamate of ammonia, hydrogen, or the ammonic chlorides, substances whose tension of dissociation are known, the calculated and experimental values agree remarkably well. Calculated by this formula the number obtained per equivalent for carbamate of ammonia was 19,000, and the number by experiment was 19,047. This general formula holds good for chemical combination under the new conditions, as well as for physical changes of state.

The function expressing the relation between temperature and pressure of saturated vapour was considered, and the history of the differences detailed. Prof. Gibbs,

of Yale College, deduced from a generalisation of thermodynamical principles the general formula—

$$\text{Log. } p = A - B \log. t - \frac{C}{t}$$

is the simplest approximate solution of the problem for physical or chemical change of state, on the assumption that in the case of dissociation one of the components is non-volatile. If the dissociating substance exists entirely in the gaseous state, then Gibbs finds the following formula expresses the relation of the partial pressures of the components, viz.—

$$\text{Log. } \frac{P}{(p_1 + p_2)^2} = -A' - E' \log. t + \frac{C'}{t},$$

where P is the pressure of the original substance, and p_1 and p_2 that of the products of decomposition. It is worthy of note that the form of the equation is in both cases the same. Gibbs has shown that the last equation gives with sufficient accuracy the varying densities of such substances as peroxide of nitrogen, formic and acetic acids, and pentachloride of phosphorus. New density determinations of great exactitude are required to verify the above laws.

The researches of Andrews on the liquefaction of carbon dioxide were discussed. As the temperature rises the approximation of the liquid and gaseous state, in the isothermal lines of the diagram of carbonic acid, becomes more and more apparent, until above the critical point, at a temperature of 48°C , the curve resembles almost completely that of a perfect gas. It is almost impossible to over-estimate the value of these researches. Prof. James Thomson suggested that the isothermal lines for CO_2 below the critical point are not discontinuous, but that the fluid at high pressure, and below the critical point, exists in three different states. The critical point could be calculated, and all the other variables of a gas, by means of Clausius's formula; and the lecturer hoped that by the determination of various constants similar laws might ultimately be applied to chemical compounds.

If we assume that our elements are compounded of elemental matter, which may have two or more essentially different forms, then we may extend the laws of observation to the discussion of this hypothesis so far as ascertaining the conditions which would regulate the transformations. Some experimentalists regard hydrogen as forming a basic substance through which new matter is compounded; and for the purposes of discussion this body may be taken as a provisional constituent. Now the stability of the element does not depend on the temperature alone, but also on the constitution of the gaseous atmosphere in which it is assumed to be dissociated. This fact has been entirely ignored, or rather not understood, by those who have discussed this subject on the basis of the developmental theory. If hydrogen is a constituent which becomes isolated from our elements at solar temperature, severance of the hydrogen will not take place provided the element is located in an atmosphere of hydrogen having a partial pressure in excess of that due to the dissociation tension for any given temperature. Now the solar atmosphere seems specially constituted to increase the stability of the presumably decomposable elements, because of the necessarily high relative tension of free hydrogen. It is evident we must consider thoroughly the physical laws of chemical action before we dare attempt to interpret the meaning of the recondite alterations which are revealed by spectral phenomena, and recent discussion has taught us that we are very far from being in a position to generalise in this field of research.

THE PRESIDENT had listened with great interest to the masterly exposition which Prof. Dewar had given to the meeting of our present knowledge of dissociation, and especially the recent developments of this important subject. He trusted that there would be a good discussion.

DR. SIEMENS had heard with the deepest attention the lucid and complete exposition of the critical state of

gaseous matter. It was impossible for him to follow the lecturer to the depths of mathematical formulæ, and he would ascend into the higher atmosphere of solar and stellar space. He was glad to hear that Prof. Dewar did not agree with solar dissociation. He wished especially to draw attention to the effect of radiant energy on attenuated matter. He believed that each ray of the sun had precisely the same dissociating power as the sun itself, and if this matter could be raised to the temperature of the photosphere, in space dissociation must occur.

Prof. ODLING said that with regard to the effect of radiant heat on highly attenuated matter in effecting decomposition and dissociation, he remembered that when Sir W. Groves first showed the decomposition of steam by balls of platinum heated in the oxy-hydrogen flame, Graham was of the opinion that the decomposition was not effected by the heat, but by light, i.e., radiant energy.

Prof. DEWAR said that he only discussed the bearing of dissociation on the question of the stability of our chemical elements. As to the source of solar energy, he had no intention of controverting the views of Dr. Siemens on that subject. He would point out that light decompositions are, as a rule, not reversible, and he would caution chemists to walk warily when using such delicate means of research as spectrum analysis, and it was, above all, most important to study the changes produced in spectra by varying physical conditions.

After a hearty vote of thanks to the lecturer, the Society adjourned to May 18th.

PHYSICAL SOCIETY.

Saturday, May 6th, 1882.

Prof. CLIFTON, President, in the Chair.

New Member, Mr. W. H. Heaton.

MR. LECY described a form of battery arranged by Mr. A. R. Bennet, of Glasgow, at a cost of 6d. per cell. The vessel and electro-negative plate consists of an iron milk or meat tin, into which is placed a porous pot containing a zinc plate stuck in a paraffined cork cover, fitting the porous pot. A solution of caustic soda is the liquid. In it iron does not rust, and is electro-negative to zinc. The electromotive force is 1.23 volts, where the Daniell is taken as 1 volt, and the Leclanché as 1.30 volts. Iron filings round the iron plate facilitate depolarisation by the escape of hydrogen from their points. The cell pitted against a Leclanché was found to ring an electric bell even longer than the latter.

Prof. GUTHRIE (in the absence of Dr. F. D. BROWN, the author) gave a summary of a paper entitled "*Notes on Thermometry*." This described a method of calibrating the tubes by means of a microscope having an extra hal-lens before the object-glass, which focussed the end of the mercury column, whilst the other lens focussed the tube, so that no alteration of the focus of the microscope was necessary in making an observation. Dr. Brown also found that a constant zero temperature was better obtained from a mixture of ice and water than from drained ice, and that it was preferable to mix the ice with distilled water rather than ordinary water.

Adding on the suggestion of Dr. Guthrie, Mr. WHIPPLE, of Kew, had found that the ice itself might be from different sources without appreciably affecting the result. Mr. Whipple called attention to the change of zero in thermometers by heating, and recommended buyers to see that makers had not let them be heated after their calibration. Mr. J. MACFARLANE GRAY suggested that the thermometers used by Regnault should be examined now, as our standards are based on his results.

Prof. CLIFTON pointed out that the half-lens in the microscope would probably distort the image of the mercury column.

Prof. GUTHRIE then read a paper on the repulsion of a suspended horse-shoe magnet by a rotating copper disc below it. He gave tables of quantitative results, and a plotted curve, showing that the repulsion varied as the square of the rate of rotation. For a surface velocity of the disc of 163 metres per minute, the repulsion was 0.41 grm.

ROYAL INSTITUTION OF GREAT BRITAIN.

Annual Meeting, Monday, May 1, 1882.

THOMAS BOYCOTT, M.D., F.L.S., Manager, in the Chair.

THE Annual Report of the Committee of Visitors for the year 1881, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The real and funded property now amounts to above £85,000, entirely derived from the contributions and donations of the members.

Fifty-two new members paid their admission fees in 1881.

Sixty-two Lectures and nineteen Friday Evening Discourses were delivered in 1881.

The books and pamphlets presented in 1881 amounted to about 270 volumes, making with 623 volumes (including periodicals bound) purchased by the managers, a total of 893 volumes added to the library in the year.

Thanks were voted to the President, Treasurer, and the Honorary Secretaries, Warren De La Rue, Esq., and William Bowman, Esq., to the Committee of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year.

The following Gentlemen were unanimously elected as Officers for the ensuing year:—

President—The Duke of Northumberland, D.C.L., LL.D.
Treasurer—George Busk, Esq., F.R.S.
Secretary—William Bowman, Esq., LL.D., F.R.S.

Managers—Right Hon. Robert Bourke, M.P.; Thomas Boycott, M.D., F.L.S.; Joseph Brown, Q.C.; Warren De La Rue, M.A., D.C.L., F.R.S.; Colonel James Augustus Grant, C.B., C.S.I., F.R.S.; Hon. Sir William R. Grove, M.A., D.C.L., LL.D., F.R.S.; Right Hon. The Lord Claud Hamilton, J.P.; Cesar Henry Hawkins, F.R.S., F.R.C.S.; Sir John Hawkshaw, F.R.S., F.G.S.; William Huggins, D.C.L., F.R.S.; John Fletcher Moulton, M.A., F.R.S.; Sir Frederick Pollock, Bart., M.A.; Mr. Henry Pollock; John Rae, M.D., LL.D., F.R.S.; William Spottiswoode, M.A., D.C.L., Pres. R.S.;

Visitors—John Birkett, F.L.S., F.R.C.S.; Mr. Charles James Busk; George Frederick Chambers, F.R.S.; Frank Crisp, LL.B., B.A., F.L.S.; Henry Herbert Stephen Croft, M.A.; Alexander John Ellis, B.A., F.S.A., F.R.S.; Mr. Charles Lyall; Robert Mann, M.D., F.R.C.S.; Henry Maudslay, M.D.; William Henry Michael, Q.C.; Hugo W. Müller, Ph.D., F.R.S.; Mr. Lachlan Macintosh Rae; The Hon. Rollo Russell, F.M.S.; John Bell Sedgwick, F.R.G.S.; Mr. George Andrew Spottiswoode.

OBITUARY.

MR. T. W. KEATES.

WE much regret having to record the death of Mr. T. W. Keates, widely and honourably known as the consulting chemist and superintending gas examiner to the Metropolitan Board of Works. The deceased was a sound and judicious chemist, of great learning, wide experience, and strong common sense. Few scientific men were his equals in the difficult art of giving professional evidence before a court of justice, making the facts clear to the comprehension of judge and jury, and baffling the device

by which counsel too often seek to hinder the statement of the truth. All who have come in contact with the deceased gentleman, whether in his official or private capacity, will gladly bear witness to his candour, uprightness, his nice sense of duty and honour, and his utter freedom from those charlatan arts by which inferior minds strive to win public attention.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 16, April 17, 1882.

Discovery of the Alkaloids derived from Animal Proteic Matters.—Armand Gautier.—Before the researches of the author and of the late Prof. Selmi, various experiments were made in the same direction. About the time when the chief organic bases were discovered, Schwann obtained from human remains substances capable of neutralising acids. In 1856, Panum, a Dane, obtained from the putrid flesh of a dog a poisonous extract, which he named sepsine. He showed that this complex matter was due to purely chemical agents and not to microscopic organisms. In 1868, Bergmann and Schmiedeberg obtained from putrid flesh a nitrogenous crystalline body, to which they also gave the name of sepsine. A year later, Zuelzer and Sonnenschein extracted from corpses an alkaloid differing from the former, but poisonous and expanding the pupils. The author then gives the dates of his own discoveries and those of Selmi.

Chemical Monograph of the Cucurbitacæ of Uruguay.—M. Sacc.—The author gives proximate analyses of the gourds consumed in Monte Video.

No. 17, April 24, 1882.

Researches on the Distribution of Heat in the Dark Portions of the Solar Spectrum.—P. Desains.—Not adapted for abstraction.

Separation of Gallium.—Lecoq de Boisbaudran.—We are often led to separate gallium oxide from other oxides by means of barium or calcium carbonate used in the cold. With barium carbonate sensible quantities of zinc oxide are precipitated, but the baryta is easily removed by means of sulphuric acid. Calcium carbonate throws down rather less zinc oxide, but the removal of the lime requires operations which complicate the process. For the alkaline earth carbonates an advantageous substitute is found in cupric hydrate, which precipitates gallium oxide more completely, and does not carry down any oxide of zinc. The copper is then eliminated by sulphuretted hydrogen, the liquid being kept acid in order to prevent gallium being rendered insoluble by copper sulphide. The treatment with cupric hydrate takes place in heat. The mixture is filtered after a few minutes. One-sixth of a milligramme of gallium diluted in a strong solution of zinc is recovered without notable loss. Copper oxide likewise precipitates gallium oxide, and separates it as distinctly from zinc oxide and from ferrous oxide. The solution is first reduced by boiling with finely-divided metallic copper; a small excess of cuprous oxide is then added, and after one or two minutes the liquid is rapidly filtered. It is practically difficult to avoid the peroxidation of a little iron during the filtration. Hence the treatment must be repeated several times, which does not cause an appreciable loss of gallium. The cuprous oxide used must be perfectly free from organic matter. The author corrects his former statement on the action of metallic cadmium upon gallium chloride. The reaction is

not complete, for a blade of zinc placed in the filtrate separates appreciable traces of gallium oxide.

Adinic Transformation of the Mirrors of Foucault and their Application in Photography.—M. de Charbonnet.—M. Cornu has shown that platinum in layers of complete transparency, unlike mirrors of polished silver and surfaces of silver deposited chemically, proves an excellent reflector for the ultra-violet rays. Foucault placed before his telescopes a plane glass covered with a semi-silvering so thin as to be transparent, but which preserved his apparatus by reflecting the non-luminous heat. This layer is therefore a *filter*, permeable to the dark rays alone, which may be used for photography without the intervention of any visible ray of light.

Equivalent of Carbon determined by the Combustion of the Diamond.—Prof. H. E. Roscoe.—The author has employed the same arrangements as MM. Dumas and Stas, but has used Cape diamonds instead of Brazilian specimens. Cape diamonds do not contain a trace of hydrogen, though they leave a little ash. 10 oxygen = 15.96, carbon becomes 11.07. M. Dumas, on communicating the above results, remarked that if oxygen is represented by 16, carbon becomes 12.002, that is a whole number within $\frac{1}{1000}$ th part.

Decomposition of the Lead Salts by Alkalies.—A. Ditté.—It is generally admitted that alkaline liquids in a slight excess determine in the salts of lead a white precipitate of hydroxide. In reality the reaction is less simple, and there are formed intermediate products, sometimes very difficult to decompose. If a certain quantity of lead chloride is suspended in water, and if potassa is gradually added, with stirring, the alkalinity quickly disappears after each addition, but the lead chloride is gradually modified. It turns slightly yellow, increases in bulk, and is finally changed into a white mass, which fills the whole liquid and is an oxy-chloride. After this moment the further addition of a trace of potassa gives an alkaline reaction to the liquid. If this oxy-chloride is carefully purified and suspended in water, the first portions of potassa added turn it slightly yellow; the liquid remains alkaline, and contains chlorine. But the proportion of chlorine varies but little on successive additions of potassa until the solution of the latter reaches the strength at which it decomposes the oxy-chloride. At this point the latter turns grey, and is quickly transformed into the anhydrous oxide.

Action of Sulphuretted Hydrogen upon Solution of Nickel Sulphate in the Cold.—H. Baubigny.—This memoir will be inserted at length.

Researches on Ozone.—M. Maillert.—It is already known that sulphur is converted into sulphurous acid by ozone. If both are perfectly dry, no sulphuric acid is formed, but if the reaction takes place in presence of water, sulphuric acid only is obtained. If an alkali is present, a sulphate is formed. With selenium and tellurium ozone gives l-kewis, in presence of water, selenic and telluric acids. Neither selenious nor tellurous acid is formed. Most, if not all, sulphides are attacked more or less rapidly by ozone. The sulphides of copper, antimony, zinc, cadmium, as well as the alkaline and alkaline-earth sulphides yield sulphates. Nickel and cobalt sulphides are first converted into sulphates, but on continuing the reaction there is formation of peroxide, and a part of the sulphuric acid is set free. Gold sulphide gives a precipitate of metallic gold and sulphuric acid. Platinum, silver, and bismuth sulphides likewise give free sulphuric acid. Mercury sulphides are only slowly attacked by ozone. Manganese, palladium, and lead sulphides are converted into peroxides, and all the sulphur into free sulphuric acid. Formene and ethylene are converted into carbonic, formic, and acetic acids. Acetylene yields carbonic and formic acids, but not acetic. Amylene gives carbonic, butyric, and valerianic acids. The formic and acetic acids, if present at all, are in very small proportions. Benzol and toluol yield carbonic,

formic, acetic, and probably other acids of the fatty series. Benzol gives also a dark brown solid, and toluol a brown syrupy liquid.

Absorption of Volatile Bodies by the Aid of Heat.—T. Schilseing.—The author remarks that the absorption of gases by reagents takes place in virtue of the mobility of their molecules. Only bodies whose molecules possess this mobility are capable of being absorbed by a short passage through a reagent. But in a great number of cases the volatile bodies which it is desired to absorb occur in the form of powders, liquid or solid, suspended in a gaseous medium. It is therefore proposed to facilitate the absorption of such matter by the application of heat, which may cause them to assume the gaseous state. The experiments described show the feasibility of this idea.

The Oxidation of Pyrogallol Acid in an Acid Medium.—P. de Clermont and P. Chautaud.—The authors conclude that the oxidation of pyrogallol acid in an acid medium by silver nitrate, chromic acid, and potassium permanganate is complex; the chief product of the reaction is purpuro-galline, $C_{26}H_{16}O_9$. On oxidising pyrogallol with permanganate mixed with sulphuric acid they obtained, in addition to purpuro-galline, pyro-gallo-quinone, and a third body not yet sufficiently examined.

Justus Liebig's Annalen der Chemie,
Band 211, Heft 2.

On Tolan-di-iodide.—E. Fischer.—This compound, $C_{14}H_{10}I_2$, is obtained by heating a dry mixture of both bodies up to the melting-point of iodine, dissolving out the unconverted matter in cold chloroform, and finally taking up the new compound in an excess of boiling chloroform, from which it crystallises out on cooling in rose-coloured leaflets.

Butylation of Aniline.—Arthur Studer.—The author examines the action of isobutylic alcohol upon aniline hydrochlorate, amido-butyl-benzol and its salts, butyl-phenol and its ethers.

Band 211, Heft 3.

Argentinian Quebracho Drugs.—O. Hesse.—An examination of various quebracho woods from a pharmaceutical point of view. He describes, as occurring in white quebracho, the alkaloids aspidospermine and aspidospermatine; aspidosamine, hypoquebrachine, quebrachine, and quebrachamine. In addition to these bases the author has obtained from the bark of the white quebracho an indifferent alcoholoid substance, quebrachol. The red quebracho (*Loxopterygium Lorentzii*), the species which is used in dyeing and tanning, contains a substance approaching catechine, and an alkaloid, loxopterygine.

Phytosterine and Para-cholesterine.—O. Hesse.—The author considers these two compounds as not identical.

Sodium Hyposulphite (Hydrosulphite).—A. Bernthsen.—A reply to M. Schützenberger on the disputed formula of this acid.

Succinyl-o-succinic Ester, the Product of the Action of the Alkali Metals upon Succinic Ethyl-ester.—F. Hermann.—The author describes this ester and its transformation-products, having a normal saturation-proportion of the carbon atoms; secondly, those transformation-products which may be deduced from a non-saturated carbon nucleus; and, lastly, the products which are to be considered as derivatives of quinone.

A Hydramide of the Fatty Series, Tri-iso-butyliden-diamine.—A. Lipp.—Not adapted for useful abridgment.

Normal Butyl-aldehyd-ammonia and Normal Amido-valerianic Acid.—A. Lipp.—The author gives a minute comparison between the properties of the latter acid and the corresponding iso compound.

A Correction.—J. W. Bühl.—The author points out an error in his memoir on the connection between the

optical and thermic attributes of bodies as printed in these *Annalen*, vol. 211, sec. 24, p. 164.

Communication from the Laboratory of the University of Würzburg.—A. Emmert and F. Reingrubler.—This consists of a memoir on dimethyl-naphthalene as one of the coal-tar oils, boiling between naphthalene and acenaphthine.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., February, 1882.

Report presented by M. Dumas, on behalf of the Committee of Constructions and of the Fine Arts, on the Manufacture of Vitrifiable Colours.—M. Lacroix.—The Committee having recently inspected the works of M. Lacroix, describe their arrangement at some length. No facts of chemical importance are given.

Various Modifications of the Gramme Machine.—This paper cannot be intelligibly reproduced without the six accompanying illustrations.

Universal Exhibition of 1878: Colouring-matters and Colours.—M. Lauth.—The author describes phthalic acid, naphthol, naphthylamine, the pyrogallol and resorcin phthalines, the colouring matters derived from azo-compounds, the indulines, the tropoelines, and artificial alizarine and its accompanying colours.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 13, 1882.

Dr. Miguel Fargas ascribes the aroma of roasted coffee to a peculiar principal, caffeine, which is developed in the act of roasting. Its action upon the heart is opposed to that of caffeine, as it increases the force and the frequency of its pulsations.

Macalline.—Dr. Rosado.—This alkaloid, obtained from the bark of the macallo, a tree growing in Yucatan, is recommended as superior to quinine in the treatment of intermittents. Neither the botanical name of the tree nor the composition and reaction of the alkaloid are given.

On Naphthol.—Savia Ambrogio.—The author finds that thymol may be advantageously used instead of phenol or salicylic acid. Naphthol is pronounced still preferable. He proposes the law that the physiological action of organic substances is inversely as their molecular weight, and directly as their specific heat. This is precisely the opposite behaviour to that of the metals, according to the law of Rabuteau.

No. 14, 1882.

Action of Aluminium upon Copper Chloride.—Dr. D. Tommasi.—Even at common temperatures aluminium reacts briskly upon a solution of copper chloride. The products of the reaction are hydrogen, metallic copper, and an aluminium oxy-chloride, the composition of which varies according to the degree of concentration of the copper solution. The oxy-chlorides seem not to be definite compounds, but mixtures in variable proportions of aluminium chloride and oxy-chloride. They are non-crystalline, and are easily decomposed if heated even in the water-bath. The solution of aluminium oxy-chloride, like that of ferric oxy-chloride, is precipitated on the addition of sulphuric acid and of certain salts. A single drop of sulphuric acid determines a coagulum of aluminic hydrate so abundant that the whole liquid is solidified. The hydrate obtained is sparingly soluble in sulphuric acid, and is probably not ordinary alumina, but an isomeric modification. Among the salts which throw down alumina from its oxy-chloride are sodium, ammonium, potassium, zinc, copper, magnesium, and iron sulphates. On the contrary, potassium, ammonium, copper, and barium chlorides, potassium bromide and iodide, ammonium and potassium nitrate, do not precipitate aluminium oxy-chloride, even at a boil.

MISCELLANEOUS.

Dephosphorisation of Iron.—At a recent meeting of the Society of Arts a paper was read, by Sid Gilchrist Thomas and Percy C. Gilchrist, on the manufacture of steel and ingot iron from phosphoric pig-iron. The authors, after stating that nearly nine-tenths of the iron ores of Europe were so phosphoric as to produce a pig-iron unfit for steel making without a process of dephosphorisation, showed that by the new lime process perfect dephosphorisation was produced, so that the steel made from phosphoric pig was actually purer than that made from hematite iron. They then instituted a comparison between the basic Bessemer process and the puddling process, pointing out that the former process was peculiarly adapted to the manufacture of soft, weldable steel, having all the characteristics of puddled iron, with considerably greater strength, elasticity, and ductility. It was stated that this soft, basic, Bessemer steel could be made for some shillings a ton less than ordinary puddled iron, while an economy of seven shillings a ton was gained in its subsequent treatment by the smaller loss which it undergoes in rolling. The authors stated that nearly half a million tons a year of the new dephosphorised metal were now being made, and that on the Continent works were erecting having a capacity of a further half million tons a year, while in England the new special works erecting had only a capacity of under 200,000 tons a year. The paper concluded by querying the wisdom of allowing continental ironmasters to push so far ahead of us in the production of this new ingot iron, which was not only cheaper, but immensely superior to puddled iron.

Test for the Purity of Magnesium Phosphate.—Prof. B. Tollens.—If a precipitate of ammonium-magnesium phosphate is contaminated with magnesium or calcium triphosphate, caustic lime, or magnesia, or the citrates of these bases, there is obtained on ignition a white mass, which, if covered with silver nitrate and heated quickly, turns yellow. This test should be especially applied when citric solutions of phosphates are directly precipitated with magnesia mixture.—*Journal für Landwirtschaft.*

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Chl rate of Lime.—Will any of your correspondents kindly give me a cheap process for making chlorate of lime? A method by chlorine gas preferred.—J.L.

MEETINGS FOR THE WEEK.

- MONDAY, May 15th.—Society of Arts, 8. Book Illustration: Old and New (Cantor Lectures), by J. Comyns Carr.
TUESDAY, 16th.—Institute of Civil Engineers, 8.
Pathological, 8.30.
Royal Institution, 3. "Digestion," by Professor A. Gamgee.
WEDNESDAY, 17th.—Society of Arts, 8. "The Constant Supply and Waste of Water," by G. F. Deacon, M.I.C.E.
Meteorological, 7.
Pharmaceutical, 11. (Anniversary)
THURSDAY, 18th.—Royal Institution, 3. "The Metals," by Prof. Dewar.
Philosophical Club, 6.30.
Chemical, 8.
FRIDAY, 19th.—Royal Institution, 8. "The Making and Working of a Channel Tunnel," Sir F. Bramwell, at 9.
SATURDAY, 20th.—Royal Institution, 3. Poetry and its Literary Forms, Professor D. Masson.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND,

Incorporated 2nd October, 1877.

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THE CHEMICAL NEWS.

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SOME OF THE DANGEROUS PROPERTIES OF DUSTS.*

By F. A. ABEL, C.B., F.R.S.,
President of the Institute of Chemistry.

(Continued from p. 202.)

NUMEROUS experiments similar to those of Marocco and Morison were made by the lecturer at Wigan with mixtures of air and coal-dust from Seaham and other collieries, in the complete absence of fire-damp, which were passed through the apparatus at different velocities up to 1000 feet per minute. Small cannon, especially constructed to ensure uniformity in the volume of flame produced at different times, were fired in them, either singly or in pairs in rapid succession; and exposed heaps of gun-cotton and of slow and quick-burning gunpowder were exploded in the dust-laden air. The results occasionally confirmed to some extent those of Marocco and Morison and the Chesterfield experiments. At velocities of 400 feet per minute the dust, which was either passing at the time or was raised by the concussion of a first shot, did not appear to produce any increase in the volume of flame furnished by the cannon, but a decided though inconsiderable lengthening of the flame was several times observed at higher velocities and with the employment of the most inflammable dusts. Some of these, when thickly suspended in air travelling at velocities of 500 to 1000 feet per minute, and exposed to the action of a large flash of flame (as produced by the loose heaps of gun-cotton and blasting powder), exhibited a tendency not only to burn explosively in and close around the flame, but also to propagate flame, or cause it to travel along some distance; but the most decisive results of these experiments were not of a nature to warrant the conclusion that flame could be carried along indefinitely, or even to a very considerable distance, by coal-dust in the complete absence of fire-damp, as now maintained by Mr. Galloway. There can be no question that the scale of magnitude upon which the first ignition in the dust-laden atmosphere is produced must greatly influence the extent to which the propagation of flame in this way will extend, and Mr. Galloway's experiments at Llwynypia, therefore, were likely to develop conditions more nearly approaching those of the real state of things in a mine than experiments in galleries of smaller dimensions, and with small initiating volumes of flame. But the necessity for caution in deducing very decided conclusions from even large-scale experiments appears to be illustrated by some of Mr. Galloway's results, inasmuch as some of the great distances to which the flame extended were observed under conditions decidedly favourable to the projection of the flame by causes which would not come into play in the same way in a mine-working. The experiments made some years ago by Mr. Hall in an adit (which have already been referred to) appear to have a more direct bearing upon results likely to be actually produced underground in a dust-laden atmosphere. In those experiments, the extreme distance to which flame was carried by dust, first ignited by the flame from a very excessive charge of powder (4 lbs.), was 180 feet. It is of course possible that the coal used was not of the most inflammable description, and that its fineness and density were not most favourable to its becoming very thickly suspended in air. On the other hand, Mr. Hall stated, in his

evidence before the Royal Commission that the atmosphere in the adit was only "practically" free from gas.

The volume of flame from a blown-out shot in a mine-working is generally considerable, but it appears that exaggerated estimates are entertained of the distance to which, in the absence of dust, the flame will be projected, and it is probable that the large volumes of flame, extending occasionally to many yards from the spot where the shot was fired, are in a great measure due to the ignition of dust raised by the concussion and rush of air at the instant of firing. Mr. Hall, in his experiments in the adit, found that the flame from the shot of 4 lbs. of powder reached to a distance of only 18 to 21 feet when no dust was present. A few months ago that official directed the attention of the lecturer to the occurrence of two accidents in the Liverpool district, each one occasioned by a shot of 1 lb. of powder blowing out its stemming without shaking or bringing down any coal. In both instances the shot lighter and two pitmen had retired about 100 feet from the seat of the shot, that is, about 30 feet in a straight line with it, and 60 to 80 feet along both directions of a working running at right angles to the drift in the face of which the charge was fired. In the case of one accident, a man was killed, and serious injuries were sustained by the other men in both instances. There were signs of charring upon the props up to, and 5 or 6 feet beyond, where the men were standing, but they did not extend farther. The drift and the level in which these accidents occurred were 5 feet high and 12 feet wide. Mr. Hall informed the lecturer that a strong impression existed among mining men on the spot that the flame of the shot, quite unaided by gas or coal-dust (the latter was known to be present) would have extended so as to produce the effects described. This appeared so at variance with Mr. Hall's experiments in an under-ground working, and with Mr. Abel's own experience in other directions, that the latter has endeavoured to obtain some precise experimental data with regard to the distance to which any burning effect from a blown-out charge of 1 lb. or 1½ lbs. of powder would extend in a mine-working, in the absence of dust. With this object he availed himself of the friendly assistance of Major Durnford, R.E., Instructor in Field Fortifications at the School of Military Engineering, Chatham, under whose direction Lieutenant Raban has carried out an instructive series of experiments in accordance with suggestions made by Mr. Abel as the work proceeded.

The locality selected for the first experiments formed a portion of some obsolete fortifications at Chatham, and consisted of a masonry gallery or *Caponier*, 8 feet 8 inches high to the spring of the arch, and 8 feet wide below the arch, to a distance of 28 feet from the closed end; from that point it tapered on one side to 6 feet along a length of 2 feet 6 inches, and was 6 feet wide for a length of 3 feet 6 inches, up to a pier or square column 4 feet by 3 feet 6 inches; round which the gallery curved, being at this part 4 feet 2 inches wide. The straight part of the gallery, from the dead wall at one end to the projecting pier at the other, was 34 feet long. In the wall to the left of the blocked end there were six narrow loop-holes up to the curve, commencing at 18 feet from the end, and 2 feet 6 inches apart; in the opposite wall there were four, commencing at the same distance and 5 feet apart. Over the wall at the blocked end of the gallery there was an opening into the outer air, and a considerable current of air passed through it along the gallery to the curved end, which led into a large narrow gallery at right angles to this wide one, and having large chambers opening into it.

In some preliminary experiments, an iron tube was let into the face of the wall at the blocked end of the gallery, so as to represent a strong blast-hole, and this was charged with 1½ lbs. of powder, unblasted in some experiments and tamped in others; some pieces of gun-cotton were suspended from the roof of the gallery, at a distance of 28 feet and farther along, and observers were stationed outside the gallery opposite the several loop-holes. But, while the pieces of gun-cotton were not inflamed, there were conflicts

* A Lecture delivered at the Royal Institution of Great Britain, Friday, April 28, 1882.

ing opinions concerning the distances at which flame was seen, probably caused by the general illumination of the gallery by the flash of the explosion. It was, moreover, found that the iron tubes containing the charges were more or less considerably torn, so that portions of the exploding charge escaped laterally. The following method of experimenting was eventually adopted. Charges of 1½ lbs. and 2 lbs. of powder, untamped and tamped, were fired from a small roughly bored out gun-block, the bore of which was 1 foot 9 inches long and 2½ inches in diameter; the gun was raised so as to project the flame right along the gallery at about its centre. A light woodwork frame, 5 feet square, was fitted with thirty-six cross wires 1 foot apart, so as to furnish thirty-six points of intersection; to each of these points a small tuft of gun-cotton was attached, and the target thus fitted was fixed vertically so as to face the charge, in the centre of which was fixed an electric fuse. In this way small charges of gun-cotton were distributed uniformly over all parts of the target, which filled a great part of the section of the gallery. The distance of the target from the charge being gradually increased in successive experiments to 20 feet, it was found that with the employment of 1½ lb. and 2 lb. charges, untamped, in three instances out of ten experiments only one, or at most two, of the tufts of gun-cotton were inflamed, this being apparently the extreme distance to which flame, or matter sufficiently hot to inflame gun cotton, was projected. At a distance of 10 feet, with 1½ lb. charges, two out of three shots did not inflame any of the gun-cotton tufts. With 1½ lb. charges firmly tamped, one tuft only of the thirty-six was fired, in two experiments, at a distance of 20 feet, while in three others no gun-cotton was inflamed.

It appears from these results that in a gallery or mine-working of an area not very dissimilar to that in which the accidents just referred to occurred, the flame or heated gases from 1½ lb. and 2 lb. charges, fired under conditions favourable to the production of the maximum flame, and its complete projection in the direction of the discharge, only reaches occasionally, and to a very limited extent, to a distance of 20 feet. No doubt a powerful air current in a mine, passing in the direction in which the shot is fired, must have a tendency to aid the spread of the flame to a greater distance, but the difference between 20 feet and 100 feet, the flame having in the latter instance extended to a distance of 75 feet along a gallery at right angles to the point of ignition, is far too great to be only ascribable to the effect of an air current in elongating the flame. As the first of the loopholes above referred to existing in the walls of the gallery was 18 feet from the shot, they could hardly affect the distance to which the flame was found to reach.* It will be observed that these results correspond with those which Mr. Hall obtained with 4 lb. charges of powder in an adit, the dimensions of which are not specified.

No gallery of large dimensions and free from the small lateral openings was available for the continuance of these experiments, but it was thought that some experiments in subterranean passages of much smaller dimensions (military countermines) might give instructive results. A so-called envelope gallery was therefore first selected for the purpose. This gallery was 5 feet 9 inches high to the crown of the arch, and 4 feet 9 inches to the springing of the arch, and only 2 feet wide. The part selected for the position of the gun and the target was straight, but the portion immediately beyond was curved. In rear of the gun, the gallery was quite open to a considerable distance. One and-a-half pound charges, untamped, were fired, and a frame-target the width of the gallery and 4 feet 6 inches high, constructed so as to give 15 points for the attachment of gun-cotton tufts, was placed at gradually decreasing distances from the gun, commencing at 20 feet. Even at a distance of only 14 feet from the charge none of the gun-cotton tufts were inflamed; but the target was blown forward about 12 feet and partly broken. It was evident that the fact of the gallery being open at the rear of the

charge greatly reduced the tendency to the projection of flame to a distance in the direction of the explosion. The resistance opposed to the movement of the air by the curvature of this very narrow gallery, a short distance in front of the seat of the experiments, may have also contributed to diminish the distance to which the flame or highly heated gases would extend. When the experiments were continued in another gallery, of the same dimensions but straight and terminating in a head, like a drift in a mine, the cannon being placed close up to the face of the drift, several of the tufts of gun-cotton were inflamed at a distance of 27 feet; one was inflamed when the target was 30 feet off, and one also at a distance of 32 feet, but none were ignited at a distance of 35 feet from the charges. Here, then, in a long gallery, narrow in proportion to its height, but in all respects representing a drift way in a mine, the distance to which the flame of a blown-out shot of 1½ lbs. of powder extended was less than 35 feet, and therefore considerably less than one-half the distance from the seat of the blown-out shot of 1 lb. of powder where the men were burned, in both directions in the cross workings, in the accident above cited. The influence of coal-dust in increasing the distance to which the flame from a blown-out shot will extend in mine workings is therefore conclusively demonstrated by a comparison of the effects of those accidents with the foregoing experimental data. On the other hand, the important circumstance noticed by Mr. Hall that no signs of burning on the props in the mine were visible at greater distances than a yard or two beyond the spots where the men were waiting, although there were open workings in both directions for some considerable distance, and although the flame was sufficiently extensive at those spots to injure the men severely, proved conclusively that coal-dust had not the power, in these two instances, to carry on the flame to a great distance from the source of fire. Had there been any gas in the air of the mine the flame would doubtless have extended much farther, and perhaps throughout the adjacent workings. The amount of dust raised by the blown-out shots may, however, have been less considerable than in other similar occurrences, and the dust itself may not have been so highly inflammable, or otherwise of so suitable a character for carrying on flame, as that existing in other mines where undoubtedly dust has played an important part in enhancing the magnitude of explosions. At any rate these results demonstrate the necessity for the exercise of caution in drawing conclusions of too sweeping a nature with regard to the causes and the extent of such coal-mine explosions as cannot be quite clearly ascribed to fire-damp. A few experiments have been made, in the largest gallery (Caponier) at Chatham, to test the power of coal-dust to carry on the flame from a blown-out shot. A large quantity of very fine and inflammable coal-dust from Seaham Collieries was suspended in the air by employment of sufficient mechanical contrivances, and clouds of the same dust were also blown into the gallery in the direction of the shot, and immediately in front of it, just when it was fired. One of the flame-screens was placed across the gallery where the pier-jutted out (at a distance of 34 feet from the shot), and pieces of gun-cotton were attached to nails driven in the wall along the short narrow part of the straight gallery and to some distance round the curve. In every one of the experiments tried (three) with 1½ lbs. of powder, fired when dust was thickly suspended and carried along in the air, the flame burned a number of pieces of gun-cotton on the screen; in two experiments gun-cotton was burned at a further distance of 1 ft. 6 ins., but not beyond; in the third, some flame travelled to the end of the straight gallery, and to a distance of 4 ft. 8 ins. beyond the curve, but gun-cotton was not inflamed beyond that point. In this case, therefore, flame reached rather more than, and in the others not quite, double the distance with dust thickly suspended in the air, to what it did in the absence of dust. Experiments will be continued in the long narrow galleries which have been spoken of.

* The closing up of these was not found to affect the results.

It must now be accepted as beyond question that very few, if any, explosions have occurred of which the destructive effects, so far as burning and production of the fatal after-damp are concerned, have not been more or less considerably increased through the agency of the coal-dust raised by the explosion, and that the latter has been in very many cases instrumental in causing the burning effects of the explosion to spread over great areas, and to reach to workings which, in the absence of dust, would have escaped the visitation. Even of late years, long since the observations of Faraday and Lyell have been confirmed and extended, mining engineers and others immediately connected with the working of coal-mines have been very prone to ascribe explosions, which did not admit of satisfactory explanation by an accidental failure of ventilation or other evident causes, to the sudden disengagement or outbursts of fire-damp, such as are, in fiery coal seams, of no uncommon occurrence, and sometimes very serious in their magnitude and long continuance, and to charge such sudden escapes of gas into some part of the mine-workings with the whole extent of the disaster, rather than to credit coal-dust with any important share in the origination or even in the extension of the explosion. In many instances the occurrence of such outbursts, following upon falls of roofs or the firing of shots, or the rapid disengagement of fire-damp from coal or goaves, consequent upon sudden changes in atmospheric pressure, have been clearly proved to have preceded disastrous explosions. In others, however, the conclusion that an explosion has been connected with the occurrence of a sudden disengagement of gas in considerable volume has been based upon assumptions or conjectures, more or less admissible, or upon evidence of doubtful nature collected after the explosion (as in the case of the recent explosion at Seaham Collieries). Under any such circumstance, however, it is, to say the least, extremely difficult to realise how sufficient gas to produce an explosive atmosphere can be conveyed, even by the most powerful ventilating currents which can circulate in mines, from the seat of such a sudden outburst to far distant portions of the mine to which the actual explosion is proved to have extended, within the period which is known, or believed, to have intervened between the first disengagement of the gas and the firing of the explosive atmosphere produced thereby in the vicinity of the outburst, by the firing of a shot, by a defective lamp, or by other means of ignition. On the other hand, the character of the effects which in many instances have been produced by the explosion; the evidences of severe burning such as could not be produced by the rapid explosion of a gas-mixture only, and the deposition of partially burned or coked dust in very distant and distinct parts of the mine workings, leave no room for doubt that coal-dust has played a more or less important part in almost all the explosions which have been of late submitted to investigation. Further, it must be conceded that in some instances coal-dust would indeed appear to have been the chief instrument of destruction.

(To be continued.)

ACTION OF CHARCOAL UPON A SOLUTION OF GOLD CHLORIDE.*

By Prof. GEORGE A. KOENIG.

AMONG the substances which decompose gold solutions, the text-books—and, as far as I could find, the special literature—do not mention charcoal. This property of charcoal has become the subject of a United States patent, claiming that by filtering liquids containing in solution gold and certain metallic salts, the gold alone would be precipitated upon the charcoal, and none of the other metals. In the spring of 1880 my attention was drawn to

this subject, and, as the fact appeared unquestionable, it became of some interest to ascertain the reactions involved.

The following possibilities suggested themselves—

1. Gold might be precipitated by the alkaline carbonates of the ash mixed with the charcoal from the charring process.
2. Gases condensed in the coal might act as reducing agents.
3. The action might be physical only, belonging to the so-called catalytic phenomena.
4. Carbon might be oxidised by auric chloride and water, either to carbon monoxide or dioxide.

Gold hexachloride was prepared as nearly free from uncombined chlorine as several evaporations to dryness could make it.

Charcoal was broken into pieces, and, by sifting, assorted to an average diameter of about $\frac{1}{32}$ of an inch. It was then digested with hydrochloric and 1 hydrofluoric acids for twelve hours, and washed first with dilute acid, then with distilled water until the latter ceased to act upon blue litmus. After drying, the charcoal was kept at a full red heat for one hour in a closed crucible. Any action produced by this purified material upon gold solution could not be ascribed to inorganic constituents.

First Experiment.—30 grms. of the charcoal were placed into a half-litre flask, and the latter filled one-half with water. Heat being now applied, the contents of the flask were kept boiling for thirty minutes, under replacement of the evaporating water. Condensed or occluded gases were now presumably expelled, and a measured aqueous solution of gold chloride, corresponding to 1.452 grms. of metallic gold, was added, whilst the flask was furnished with a doubly perforated cork, and left at ordinary temperature for two hours, when the yellow colour of the liquid had disappeared and the charcoal became coated with gold. Having now connected the flask on one side with a Geissler potash bulb, filled with aqueous barium hydrate, and on the other with a gasometer, containing pure air, the flask was again brought to boiling, while a slow current of air passed into the flask, the air passing through several U-tubes containing sodium hydrate. A turbidity in the barium hydrate became visible at once, and after fifteen minutes of boiling the precipitate of barium carbonate was determined as barium sulphate with the usual precautions.

$\text{BaSO}_4 = 0.070 \text{ gr.} = 0.0036 \text{ C.}$

Now, according to the equation—



we have—

$784 \text{ Au} : 36 \text{ C} = 1.452 \text{ grs. Au} : 0.0666 \text{ C} ;$

that is to say, that only about one-twentieth of the gold was precipitated by the chemical action of charcoal.

A closer examination of the charcoal showed a marked difference. Some pieces had a brilliant compact coating of gold, others a dull porous coating, and many none at all.

Second Experiment.—Lampblack was strongly heated in a closed crucible to redness. It was then washed with hot water and again dried. If the action of the charcoal were chemical, then lampblack should act more readily. In order to test this assumption 0.2 grm. of gold, as chloride, was dissolved in 100 c.c. of water and 6 m.grs. of the above lampblack added. A disengagement of gas was noticed at the boiling heat, and also a slight precipitation of gold. Boiling was kept up for two hours, when the liquid was still coloured from gold chloride. Again 6 m.grms. of lampblack were added and boiled for three hours longer with a condenser attached. The liquid was now filtered and still yellow in colour, while the precipitated gold was largely mixed with lampblack. After ignition the gold weighed 0.0495 grm., or nearly one-fifth of the quantity contained in the liquid.

These experiments do not cover the entire field of inquiry upon the subject, but they seem to indicate a parallel physical and chemical action, the former depending upon

* From the Journal of the Franklin Institute, May, 1886.

the surface and capillary condition of the charcoal, lamp-black not acting physically at all, the latter depending upon a combustion of carbon into carbon dioxide.

University of Pennsylvania, March, 1882.

ON TWO JAPANESE METEORITES.*

By EDWARD DIVERS, M.D.

THESE meteorites are the property of a gentleman, Mr. Naotora Nabeshima, formerly Daimiyo of Ogi or Koshiro, in the province of Hizen, Japan. They are heirlooms in his family, and used to be in the care of the priests of one of the family temples in Ogi, called Fukuchi-in Gomado. After the revolution, the temple was closed, and the meteorites restored to the keeping of their present possessor.

In the family archives there is a record of these stones having been entrusted some years after their fall to a priest named Jishobo, which is dated the 7th day of 11th month of the 1st year of Yenkiu (Dec. 10, 1744); Jishobo's receipt for them is also preserved. They must therefore have fallen about 150 years ago. They used formerly to be among the offerings annually made in the temple in Ogi to Shokujo (Tanabatsume) on her festival, the 7th day of the 7th month. There is no mention of them having fallen on this day in the year, but they were connected with her worship by the belief that they had fallen from the shores of the Silver River, Heavenly River, or Milky Way, after they had been used by her as weights with which to steady her loom.

For the above particulars I am indebted to my friend and former pupil, Mr. Nakano, now one of the instructors in Kobudaigakko (Imperial College of Engineering, Tokiyo).

The meteorites are somewhat similar in appearance, being angular masses, evidently fragments, irregular quadratic pyramids in shape. The apex of the pyramid in the larger stone is obliquely truncated, as is also one of the basal angles of the smaller one. In the smaller one, the region of the rounded off apex shows a number of small pits or depressions. Faintly marked, thin ridges and streaks, are to be seen on both stones, radiating with some regularity from about the centre of the base over the basal edges towards the apex. The edges and faces are all rounded off, and have a very thin, nearly black, coating, such as is generally found on meteorites. This coating in the larger stone is entire, except at one corner, where it is slightly broken away. The smaller one has its surface more damaged, and has therefore been used for the chemical analysis. The interior of the stone is light grey in colour, earthy, porous, somewhat soft, and interspersed with particles of metallic iron, and a few of iron sulphide. No other minerals have been clearly made out.

The black coating, which is hard and somewhat shining, is readily attacked by hydrochloric acid, very slightly effervescing with a weak smell of hydrogen sulphide, and seems to be formed of iron, partly oxidised and sulphurised. It is just such a metallic facing as might be caused by the friction of cosmic dust, probably of like composition to the meteorites. This friction, which may have been going on for a long period during the flight of the stones through space, would also have produced that rounding off of their edges and faces which is so marked.

The larger meteorite weighs 5.6 kilograms, and the smaller at first weighed about 4.6 kilograms. Their sp. gr. is 3.62, as determined in a fragment of the smaller one, without, however, any special precautions having been taken to displace all air in its pores.

The chemical composition of the smaller of the meteorites has, by my direction, been determined with much

care and skill by Mr. Shimidzu, one of the students of the Koku dai Gakko, at present educating as a chemist.

PERCENTAGE COMPOSITION.

Elementary.

| | |
|--------------------------------|-------|
| Oxygen | 33.18 |
| Iron | 26.13 |
| Silicon | 17.15 |
| Magnesium | 14.02 |
| Sulphur | 2.15 |
| Nickel with trace of cobalt .. | 1.99 |
| Calcium | 1.39 |
| Aluminium | 1.00 |
| Sodium | 0.72 |
| Manganese | 0.57 |
| Tin, with trace of copper .. | 0.15 |
| Phosphorus | 0.15 |
| Potassium | 0.13 |

99.01

With the Oxygen Distributed.

| | |
|-------------------------------|-------|
| Iron | 15.35 |
| Nickel, &c. | 1.75 |
| Manganese | 0.18 |
| Tin, &c. | 0.15 |
| Iron mono-sulphide | 5.91 |
| Iron chromite | 0.61 |
| Phosphoric oxide | 0.34 |
| Silica | 36.75 |
| Magnesia | 23.36 |
| Iron monoxide, as silicate .. | 8.64 |
| Lime | 1.94 |
| Alumina | 1.89 |
| Sodium oxide | 0.97 |
| Potassium oxide | 0.16 |
| Manganese monoxide | 0.51 |
| Nickel oxide | 0.30 |

99.01

Mineralogically arranged.

| | | |
|--|-------|--|
| Nickel iron | 17.43 | { Cont. silica 13.10 = 39.83 per cent of the silicate. |
| Iron sulphide | 5.91 | |
| Silicate, sol. in hydrochloric acid, Olivin | 32.89 | { Cont. silica 24.30 = 56.30 per cent of the silicate. |
| Silicates, insoluble in acid .. | 43.16 | |
| Iron chromite | 0.61 | |
| 100.00 | | |

These meteorites belong, therefore, to that large class which are formed of particles of iron disseminated through a granular earthy mass, and which contain about three-fourths of their weight of iron in the free and combined states. Prof. Nordenskiöld has shown (*Färbuch f. Min.*, 1899, p. 77) that if the quantities of oxygen present are neglected, many members of this class exhibit even the same proportions between their elements. On re-calculating the composition of the Hizen meteorites in accordance with this plan, it is found to be practically identical with that of the cementing substance (I.) of the Orvinio meteorites, which fell near Rome on August 31, 1872; and to differ but little from the granular matter (II.) of the same meteorites, as well as from other meteorites. Among these is one which fell in this country in Tajima, on February 18, 1880, and of which an analysis by Dr. Korschelt is to be found in a recent number of the *Transactions of the German Asiatic Society, Tokyo (Mitt. der d. Ges. f. Natur und Völkerkunde Ostasiens, iii., 204)*. The calculated numbers are contained in the following table:—

* A Paper read before the Asiatic Society of Japan, Tokiyo, Feb. 9, 1882. Communicated by the Author.

| | Hizen. | Orvinio. | | Tajima. |
|---------------------|--------|----------|--------|---------|
| | | I. | II. | |
| Iron | 39.70 | | | 43.65 |
| Manganese .. | 0.86 | | | — |
| Tin | 0.22 | 44.7 | 43.29 | 42.55 |
| Sulphur | 3.27 | | | 1.10 |
| Phosphorus .. | 0.22 | | | 0.30 |
| Chromium .. . | 0.43 | | | 2.25 |
| Silicon | 26.06 | 26.09 | 26.65 | 24.47 |
| Magnesium .. | 21.30 | 21.28 | 20.18 | 19.56 |
| Nickel and cobalt.. | 3.02 | 3.16 | 4.71 | 3.86 |
| Calcium | 2.11 | 2.46 | 2.56 | 2.80 |
| Aluminium .. . | 1.53 | 1.75 | 1.91 | 1.37 |
| Sodium | 1.09 | 1.59 | 1.10 | 0.38 |
| Potassium .. . | 0.19 | 0.38 | 0.34 | 0.26 |
| | 100.00 | 100.00 | 100.00 | 100.00 |

The interesting fact is thus seen that meteorites which fell in this country one hundred and fifty years ago have the same composition as some of those which have fallen recently, both here and on the other side of the world.

Notes on the Analysis.—Some of the particles of the iron were somewhat rusted from age. If allowance could have been made for this absorption of oxygen and water from the atmosphere, the difference of the total found from one hundred would be less than it is. The portion used for the determination of the silica in the parts soluble and insoluble in acid was small, and was taken separately from the portion, very much larger, used for the main analysis. It is therefore not surprising, when the structure of such a meteorite is considered, to find the sum of the two quantities of silica about half a per cent greater than the total determined in the main quantity. The metallic part of the meteorite was separated from the earthy part by mercury chloride solution. The portions for analysis were removed from the meteorite by a steel drill at a part where the coating had been broken away, in order to damage the meteorite as little as possible. The drill was examined before and after use under a magnifier to obtain the assurance that it did not sensibly contribute its own substance to the dust obtained. A small fragment was rubbed down by a practised worker to serve for microscopic examination, but the earthy matter was too soft to resist the tearing strain of the tenacious iron particles.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING APRIL 30TH, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYNOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington; and late Deputy Medical Officer of Health for the City of London.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

May 4th, 1882.

SIR,—In the following tables you will find recorded the results of our analyses of the 154 samples of water collected by us during the month of April, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 154 samples, seven were recorded as "very slightly turbid." The remaining 147 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from April 1st to April 29th inclusive. The purity of the water in respect of

organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 22 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 22 samples from the mains of the East London Company, the whole, excepting three which were "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 22 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 22 samples from the mains of the West Middlesex Company the whole were found to be well filtered, clear, and bright.

Of the 22 samples from the mains of the Lambeth Water Company, the whole were found to be well filtered, clear, and bright.

Of the 22 samples from the mains of the Grand Junction Company, four were found "very slightly turbid." The remaining 18 samples were well filtered, clear, and bright.

Of the 22 samples from the mains of the Southwark and Vauxhall Company, the whole were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It will be seen from the tables that, during the month of April, the condition of the water supplied to the Metropolitan, in respect to clearness and to freedom from brown colour and excess of organic matter, was on the whole considerably in advance even of its condition during the preceding month, despite a few exceptional cases of higher colour and slight turbidity occurring during the last week, and depending on the flooded state of the river.

We have the honour to remain, Sir,

Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYNOTT TIDY.

PROCEEDINGS OF SOCIETIES.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, March 23, 1882.

MR. JOHN GLOVER, Vice-President, in the Chair.

THE minutes of last meeting were read and confirmed.

Mr. Gibb and Dr. H. S. Pattinson were elected as scrutineers of the voting papers.

THE CHAIRMAN.—Our first business to-night is in connection with Mr. Scholfield's gift. The Committee have had the matter under their consideration to-night, and they have resolved to recommend to the general meeting that it be left in the hands of the new Committee about to be elected, and that they be desired to go fully into the details and arrangements for the appropriation and award of the prize at a special meeting, to be held as early as possible, so that the result of their labours may be made known before the next session.

Mr. BERKLEY moved that the recommendation of the Committee be adopted.

Mr. STARK seconded the motion, which was carried after some discussion.

THE CHAIRMAN.—The next item is one which will excite the sympathy of every one. It is that we should formally record the esteem in which we hold the late Professor

Marreco, whose death since our last meeting has deprived the Society of one of its most active members. I have, therefore, to move the following resolution:—"That this Society has learnt with deep regret the death of Professor Freire-Marreco, who initiated the movement which led to the formation of the Society, who filled for many years the offices of Secretary and Editor of the *Transactions*, and who for two years occupied the position of President. The Society wishes to place on record its esteem for Professor Marreco personally, and its sense of the valuable services which he has rendered to it from its foundation up to the time of his death."

[[The resolution was carried unanimously, and the Secretary was desired to forward a copy of it to the family of Prof. Marreco, with an expression of sympathy and condolence from the Society.]

The CHAIRMAN—We have next to take the discussion on Mr. Pattinson's paper. It is matter for regret that Mr. Pattinson is not here himself; but Mr. Kay is present, and will be able to reply to any questions which may be put to him on the subject.

Mr. GRUB—I was a good deal interested in the paper. It is a subject which seems principally to have interested metallurgists, and which analytical chemists have done very little in. Abel and Field's method was very disappointing, and was soon thrown over for one of the methods which are now in use in metallurgical laboratories. Mr. Pattinson's method must be very clumsy where the copper is at all coarse and contains much impurity. The process of distilling off the arsenic as chloride is much simpler, and is applicable to precipitates and coarse coppers as well as to purer metal. It has the advantage of separating the arsenic completely from the other impurities. The copper is simply boiled with ferric chloride, and the distillate collected; from this the arsenic is precipitated either as sulphide or as magnesia salt. Another process, which is frequently used, and which is very convenient when the copper contains iron, consists in dissolving in nitric acid, supersaturating with ammonia, and passing sulphuretted hydrogen. In this way practically the whole of the arsenic remains in solution, and can be thrown down as sulphide from the filtrate by acidifying. About twelve years ago I had a series of comparative analyses made by the processes which were then known to us. Abel and Field's method gave us 91 per cent, direct precipitation from fine copper by magnesia 93 per cent. and the ammonium sulphide method 96 per cent.

Mr. GREEN—The ammonium sulphide method was given up in the case of precipitates, because the magnesia present in the common salt used took down a quantity of the arsenic when the solution was made alkaline with ammonia.

Mr. KAY—No doubt Mr. Pattinson's process is adapted to coppers which contain no large quantity of impurity, and with such metals the method is as quick as the distillation process. The distillation process would be objectionable in an ordinary laboratory. The process, as described by Mr. Pattinson, can be carried out very quickly in the hands of one accustomed to the method. The whole estimation need not take more than one day.

Mr. GREEN—The distillation takes about twenty minutes, and the whole estimation can be done in three hours. We estimate our arsenic volumetrically, however.

Mr. KAY—Mr. Pattinson's process is exceedingly delicate. We can detect and estimate by it 0.01 per cent. Such accuracy may not perhaps matter when the copper contains much impurity, but in copper which is nearly pure it becomes of importance; and we find that, under proper conditions, there is no necessity to let the magnesia precipitate stand, but that the filtration may be proceeded with immediately.

Mr. GRUB—It is quite contrary to our experience that there is any safety in filtering at once.

Mr. KAY—I know that is the general impression of chemists, but it is quite a mistake if proper precautions are taken.

The CHAIRMAN—We are indebted to these gentlemen for the information they have given us. It is a subject to which I cannot offer any valuable contribution; but one thing seems clear, that is, that quantities of impurities in commercial metals, which, a few years ago, would have been considered so small that they could safely be neglected, are now no longer so; but their determination has become a question of importance, and our analytical methods have to be improved to meet the want.

The following papers were read:—

"A Lecture Experiment," by Wm. JOHN GREY.—Mr. T. Liddle, a student of mine, noticed on passing SH_2 through a warm HCl solution of a substance given him for analysis that the gas took fire in the liquid. I found that the substance contained KClO_3 , and repeated the experiment with a warm HCl solution of that salt. Doubtless the SH_2 inflames in the O_2Cl_2 dissolved by the liquid. The experiment would be a striking one for lecture purposes.

"On the Solubility of Sulphur Dioxide in Sulphuric Acid," by J. T. DUNN, M.Sc.

The Scrutineers then declared that the following had been elected officers for the ensuing year:—

President—B. S. PROCTOR.

Treasurer—John Pattinson.

Secretaries—J. T. Dunn, W. W. Proctor.

Auditor—N. H. Martin.

Committee—P. A. Berkeley, G. France, A. S. Herschel, C. P. Laidler, John Morrison, H. R. Procter, W. C. Reid, W. Rennoldson, H. Scholefield, T. W. Stuart.

Votes of thanks to the authors of papers terminated the proceedings.

NOTICES OF BOOKS.

Rivers' Pollution Prevention Act, 1876. Report to the Local Government Board. By Dr. R. ANGUS SMITH, F.R.S., One of the Inspectors under the Act. London: Printed by G. E. Eyre and W. Spottiswoode for Her Majesty's Stationery Office.

We have here a most important contribution both to sanitary and industrial chemistry. The author treats in the first part on water and sewage. He sets out with examining the changes effected by oxygen upon organic matter dissolved or suspended in water, and especially the formation and destruction of nitric acid. Dr. Angus Smith has long ago held that the mere presence of organic matter in water is no proof of unwholesomeness. For this purpose the quality as well as the quantity of such matter must be known. Hence he considers that the development of organisms in water should be studied microscopically. On the question of nitrification he concludes that organic matter containing nitrogen produces nitrates by oxidation under certain conditions, whether living organisms are present or not. Inorganic matter containing ammonia does the same. Albuminous matter, when putrefying with plentiful access of air, also oxidises the organic nitrogen. On the other hand there are putrefactive conditions, where nitrates are deoxidised and free nitrogen evolved in quantity. That this action is due to organisms may be doubted, as it is active at 71° F. In one experiment 1100 c.c. of water containing 10 per cent of excreta and 2 grms. of nitre gave off 218 c.c. of pure nitrogen. The whole amount of nitrogen present in the nitre was 220.6 c.c. The author thinks that this decomposition of nitrates is a reversed putrefaction, and should be carefully noted in considering the action of disinfectants. In summing up the facts he concludes that nitric acid is formed when there is a certain amount of sewage in the water, but it is overcome by an excess of air. On the other hand, when the sewage is in excess, the nitrates are destroyed. If we duly consider this double process we

shall become convinced of the futility of all attempts to estimate the amount of contamination which has existed in water from an analysis of its present ingredients. We see, also, that water, however contaminated, has a power of self-purification, which may extend even to the germs of disease. It is an interesting fact that mere agitation with air keeps sewage without smell for two or more weeks, even in warm weather. We would beg to remind recent inventors that the purification of sewage by a current of air driven through it by mechanical agency, was claimed more than ten years back. The decomposition of sewage appears to differ in its quality from that of excreta not mixed up in water; the latter giving off more ammonia, but the former having a more markedly injurious action. Prof. Frankland, if we remember rightly, contends that the bubbles which rise from polluted waters as they burst project moribund particles into the air. The effects of aeration are the delay of putrefaction, the increase of nitrates, and the withdrawal of ammonia.

As a possible method of purifying sewage, Dr. A. Smith suggests that putrefaction might be first allowed its full action in order to decompose much of the organic matter, and probably to break up the living organisms themselves into gases or intermediate products, and that the process should then be completed by aeration. Oxidation is found to take place very rapidly after putrefaction. But at what stage of putrefaction, if at any, the disease germs are destroyed is not yet known. Beings much higher in the scale, such as trichinae, seem to be little, if at all, affected when placed in the midst of putrescent animal matter.

The author, however, by no means recommends this process of purification by putrefaction to be carried on in our streams. Whilst admitting that "disease has not to any very marked extent been observed as following the use of sewage irrigation," he considers that there may be danger where the sewage has been transmitted to the soil too rapidly. He adds: "On this point we must refer to the remarkable inquiry by Dr. Greenwood. At a mill near Bingley, wool sorter's disease and malignant pustules had broken out among those who worked with mohair coming from Van. To disinfect the wool it was exposed to the air on a field. In a few days a cow died in a field which received the village sewage, and next month cattle and sheep were attacked by anthrax."

A striking instance has occurred lately in France. A tripe-dresser in a large way of business had been in the habit of passing all his washing waters and trade off into a pond on his premises. In course of time the pond was complained of as a nuisance. To get rid of this the owner obtained the consent of a neighbouring farmer for the water and the mud to be conveyed to his fields. The result was a very severe and obstinate outbreak of diphtheria.

Dr. Angus Smith asks: "What advantage would it be to a city to send down its sewage into a river in a condition in which it did not putrefy if it were to have an appearance of impurity as great as ever?" Something more is demanded, and appearance is perhaps the chief point. For, be it observed, "we have not proved any disease to occur from the sewage below Glasgow or Manchester." If this is the case,—and we cannot for a moment question the author's statement—how very trifling becomes the boast of the irrigationists that the vicinity of their farms is not marked by increase of epidemics!

As regards fish, Dr. Angus Smith remarks that sewage is an excellent feeder of fish, though these do not enter the places where sewage is very strong, and never at all where there is putrefaction going on. This is the exact truth. "The point where the sewage of Kingston entered the Thames was, about seven years ago, a favourite spot for anglers." On the other hand, we have repeatedly been informed that sewage fish becomes offensive with exceptional speed.

As regards the use of lime for the treatment of polluted waters, the author admits, somewhat drily, "that something more would not be a disadvantage."

Mention is made of the use of alum in India and China for purifying drinking-water by precipitation. It may here be noted that by means of this simple expedient the French troops in Cochinchina are now almost completely preserved from the very malignant dysentery there prevalent. The same method has been used by Mr. Peter Spence for removing the yellowish peaty tinge from the Manchester water.

Concerning the waste-waters from dye- and print-works, the author very judiciously recommends that the various kinds of refuse should be allowed to mix together, and to a great extent precipitate each other. Chloride of calcium is recommended as a precipitant where it can be obtained as a waste-product. We see with much interest that Dr. A. Smith recognises a point in the treatment of sewage which certain other authorities on the question have overlooked, and have thus been led astray. He points out that if effluents are agitated with the precipitant the result is to a great extent frustrated. The inefficiency of lime for dealing with certain colouring-matters in waste-water is fully admitted. This was noted in case of peat-water, where 2 grs. of lime per gallon intensified the colour. Tan liquors also were darkened in colour by the addition of lime. Similar facts have been frequently noticed in the treatment of the Leeds sewage, which contains much water from tan- and dye-works. The yellowish brown liquid was darkened to a rich mahogany shade by treatment with lime, whilst it could be completely decolourised by the addition of cake alum, and still better aluminium chloride.

But we must pass to that very sore subject the reformation of the alkali-waste heaps and their drainage. What a nuisance such heaps are is but too well known at St. Helens, Widnes, Newcastle, and Glasgow. The process of Mr. Mond recovers a large proportion of the sulphur contained in the waste, and leaves, it appears, a certain profit. But, as Mr. Worsley, of Netnam, shows, the profit is but small, and the manufacturers naturally prefer to use their capital in other directions.

Another process is in use at Dieuze, in Alsace. It was first suggested by Dr. E. Hofmann, developed by Dr. E. Kopp, and has been further improved by M. Marchal. Dr. Angus Smith gives an extended account of the process as described by Prof. Rosenstiel, of Mulhouse. It consists of six distinct steps, transformation of the waste into soluble sulphur compounds, or so-called yellow liquors; precipitation of the sulphur by the acid of the chlorine residues, and their subsequent neutralisation; removal of the iron by fractional precipitations; precipitation of manganous sulphide; combustion of this sulphide, and the utilisation of its ash. The principal novelty of the process, which has been at work since 1867, is the incorporation with the tank-waste of a certain amount of the sulphides of iron and manganese. By this means 44 per cent of the total sulphur contained in the waste is extracted in a soluble form within eight days. The process furnishes two useful products: sulphur, either free or combined with manganese; and a regenerated oxide of manganese, fit for yielding chlorine. The solid refuse is a mixture of calcium sulphate and carbonate with insoluble iron and manganese oxides. The liquid portion is calcium chloride.

The Macfar process, devised and successfully carried out at the St. Rollox Works, depends on the decomposition of calcium sulphides by hydrochloric acid in presence of a source of sulphurous acid. The author is of opinion that the application of some form of this process to the waste drainage of St. Helens and Widnes would not merely reduce the nuisance complained of there, but would form a profitable means of utilising the great surplus of hydrochloric acid. This acid can scarcely be advantageously employed in the manufacture of bleaching-powder, as there are already serious complaints of over-production.

Dr. Angus Smith has himself devised a process, which turns on treating the extract of the waste-heaps with

manganese peroxide. The process does not succeed with strong solutions, and the sulphur present in the hypsulphites is not precipitated.

For a description of the process of Messrs. Helbig and Schaffner, we may refer the reader to Professor Lunge's well-known work on "Sulphuric Acid and Alkali." It is being completely tried at the works of Messrs. Chance, near Birmingham, and as far as the production of sulphuretted hydrogen and its combustion are concerned the success is complete. In conclusion, the author strongly urges manufacturers to turn their attention to the recovery of sulphur, not merely as a question of public health, but of economy. Vast quantities of sulphur, now thrown away daily, are capable of being used over again. That a certain outlay is required for this purpose must be admitted. But our present system of allowing the tank-waste to remain literally as waste is not free from expense. In some parts alkali manufacturers are compelled to buy or rent land where this unsightly refuse may be deposited, and have to live in peril of litigation on account of the nuisance which it may occasion. On the Tyne the waste is carried away in specially-constructed steamers and barges and emptied into the sea!

Dr. Angus Smith's work will be most welcome both to sanitary reformers and to chemical manufacturers, and cannot do other than enhance his well-earned reputation.

City and Guilds of London Institute for the Advancement of Technical Education. Report to the Governors, March 13th, 1882. Gresham College.

THIS Report, which was laid before the Governors at their meeting, contains not a few gratifying features. The acceptance of the Presidency of the Institute by H.R.H. the Prince of Wales is a proof that our future sovereign fully appreciates the importance of the movement and recognises its influence upon our national interests. No fewer than eight additional City Companies—viz., the Grocers, Skinners, Vintners, Tallow-chandlers, Plumbers, Wheelwrights, Bowyers, and Carriers—have become contributors to the funds of the Institute. We learn that the Drapers Company have munificently given £10,000 towards the expense of erecting and fitting up the Technical College at Finsbury, which raises their total contribution to £20,000. The Goldsmiths have contributed the like sum; the Clothworkers £19,000, in addition to the important support which they have extended to the Yorkshire College of Science at Leeds. The Fishmongers have contributed £18,000, and the Mercers £8000. Others of the City Companies have also come forward in proportion to their means, and to the extent in which their especial "art or mystery" is likely to be benefited by the operations of the Institute. A thought here strikes us as regards the future: seeing how largely the efficiency—we might say the very existence—of the Institute depends on donations and annual subscriptions from the Corporation and the Guilds, what would be its position if these bodies should by legislative interference be deprived of the means for continuing their liberality? The Council, as we see from this Report, are appealing to the Corporation and Livery Companies for "increased and additional contributions"; and such contributions are needed if the Institute is to come forward as a successful competitor with the Polytechnic Schools of Aix-la-Chapelle, Zurich, &c. The present income of the Institute shows, indeed, a surplus on the present limited expenditure, but such surplus is likely to be absorbed by provisions for the Building Fund. Parenthetically we would here express the hope that the Institute may guard against an error sometimes perceived in colleges, museums, &c., where efficiency is sacrificed to appearance, and where, in the words of Waterton,—

'The walls are thick, the servants thin
The gods without, the devil within'

The Council are anxious to follow up what they have

begun. They wish to widen the curriculum of Finsbury College, so as to adapt the instruction to industries hitherto left out in the cold. They wish to establish on the south side of the river a Technical College similar to that at Finsbury. They are seeking to found a Technical School for girls, where young women may receive instruction in those trades which appear suitable for female handicraft; and they wish especially to do more than they have hitherto been able towards promoting technical training in the great manufacturing centres of the Provinces. They are continually asked to extend their operations in these directions, and all that is needed is an increase of funds.

We are glad to find that the Council duly recognise the importance of a preliminary training in pure science. Without this basis technology must degenerate into mere routine and rule-of-thumbism. At the same time we venture to express the hope that the opposite error of requiring a knowledge of irrelevant matters will be avoided with an equal care, especially as this is a peculiarly English shortcoming, and has taken deep root, e.g., in the "Science and Art Department." We can scarcely pronounce it judicious to demand a knowledge of botany from students in dyeing and tissue printing.

As regards the instructions given in technical chemistry, we consider the Institute fortunate in having secured the services of so indefatigable and successful a worker as Dr. H. Armstrong, F.R.S.

The number of students who come forward as candidates at the various examinations is increasing, the proportion of those who pass is satisfactory, and many of the examiners report most favourably of the character of the answers given, and of the evident increase of knowledge in comparison with the earlier examinations. The difficulty is how to arrange these examinations so as to fairly test the practical attainments of the students as distinguished from the results of mere verbal memory. It is conceivable that, e.g., a student from a careful study of books might have acquired the power of passing a good examination in dyeing and tissue-printing, and yet be unable to dye a skein to shade, to mix a colour so as to be capable of use, or even to identify a dye-ware. There is considerable difference of opinion whether the theoretical training of the College or Polytechnicum ought to come after or before a practical course in the workshop. Many eminent German authorities maintain that a lad ought to work for two or three years in, e.g., a dye-house before entering upon the study of chemistry and physics and their special application to the tinctorial arts. We should incline to the opposite opinion. In any way theory and practice must be had in combination, and the misfortune is that too many of our industrialists, whether employers or employed, are not well versed in either. A German contemporary remarked only a few days ago:—"English industry is so far in the background, both in dyes and in their collocations, that even with the best will the importation of foreign textile goods must continue." And, again:—"English dye-works are on a large scale, but they dye no excellent colours." A lecturer in Manchester represents our dyers and printers as replying to such charges that they could turn out colours equal to any in the world, only that ordinary work pays them better. We reply that all men must sooner or later lose the power of doing what they never practise. Let us hope that in this as in other departments the action of the City and Guilds of London Institute may open the eyes of our practical men to their own shortcomings.

Appointment.—Dr. Meymott Tidy, Professor of Chemistry and of Forensic Medicine at the London Hospital, has been appointed, on the nomination of the President of the Royal College of Surgeons, Scientific Analyst to the Home Office in cases of poisoning, jointly with Dr. Stevenson, of Guy's Hospital, nominated by the President of the College of Physicians.

CORRESPONDENCE.

ON THE EQUIVALENT OF CARBON.

To the Editor of the Chemical News.

SIR,—A note by Professor Roscoe "On the Equivalent of Carbon Determined by Combustion of the Diamond," in the *Comptes Rendus* (No. 17, April 24th, 1882, p. 1180), gives the results of six experiments with Cape diamonds, taking the combining weight of oxygen as 15.96, that of carbon is given as 11.07. This startling result has also appeared in an English journal.

Feeling sure that 11.07 was a misprint of 11.97, I have just calculated the number from the weights of diamond and carbon dioxide given, and find 11.973.

Hoping that this may prevent diffusion of a startling misprint,—I am, &c.,

W. H. DEERING.

Woolwich Arsenal, May 20, 1882.

VERTICAL VIBRATION.

To the Editor of the Chemical News.

SIR,—Might I draw the attention of some of your readers to this point? I have often noted, with much curiosity, that on striking the edge of a large bowl, full of water, with a heavy instrument, the water has assumed a series of beautiful, corrugated waves, mathematically exact in relation to one another. In a circular vessel, for instance, the first sign is concentric rings from the centre; these rings become striped radially (so to speak), and on hitting harder these break up, and the surface becomes like a star of roof-shaped waves, widening outwards; a still harder and closer blow, and the whole surface appears like rough <-shaped links interfitting with one another, becoming more and more spherically inclined, and so forth. There is a law at work here, for it always gives the same results. We see the ground plan of vibration in plates upon which sand, &c., has been sprinkled before setting them in motion; but with water we have also the vertical section of these motions,—we have pictured before us the force in every direction (as confined by circumstances); certainly an interesting point.—I am, &c.,

D. Y. C.

Leeds.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal de Pharmacie et de Chimie.
April, 1882.

Action of Iodine upon Methylated Spirit.—M. Ordonneau.—The author shows that tincture of iodine cannot be made with such alcohol, as a pungent irritating compound, acetone mono-iodide, is formed at the expense of the acetone, which is always more or less present in the methylated alcohol employed.

Determination of Sugar with Fehling's Liquid.—E. Boiret.—The author proposes the following method for ascertaining if the reduction of the copper is complete: There are placed upon each other two fragments of white filter paper. Upon the upper fragment there is placed, with the stirring rod, a drop of the boiling mixture of Fehling's liquid and of the saccharine solution, holding cuprous oxide in suspension. The paper acts as a filter, and only the copper in solution, and consequently not

reduced, arrives on the lower paper. Upon the drop thus filtered there is laid a drop of a dilute solution of potassium ferrocyanide, and the paper is dried over a spirit-lamp. If there is an appreciable quantity of copper the spot, on drying, is surrounded with a rose-coloured halo. If there is a mere trace, the characteristic rose tint appears on moistening the spot with a drop of acetic acid. If the copper is entirely reduced, heat and the application of acetic acid produce a blue spot, due to the decomposition of the ferrocyanide.

Colouration of Maccaroni, &c., with Chrysianiline.—M. St. Mercier.—This colour, otherwise known as aniline yellow, is now often substituted for saffron. Dilute sulphuric acid instantly discharges the colour of chrysianiline, but leaves the yellow of saffron unaffected.

American Lard.—Much of this is a mixture of tallow, stearine, oleomargarine, fat of bacon, &c.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., March, 1882.

Electric Transportation of Energy.—Maurice Lévy.—The author concludes that the transportation of a given quantity of energy to any distance whatever, with a given yield, finds no solution in the laws hitherto enounced. These laws, scientifically exact, are illusory in practice, because their application would require either an unlimited increase of the electro-motor force, which would render insulation impossible, or the indefinite decrease of the quantity of energy transported, which would render the operation useless. The problem may, however, be practically solved by connecting together a larger or smaller number of machines, not in tension but in quantity. There is nothing to be gained by the construction of machines of colossal dimensions.

Colouring-Matters and Colours at the Universal Exhibition of 1878 (Continued).—M. Lsuth.—This memoir opens with the strange assertion that "almost all the indigo consumed is furnished by three countries, the Dutch Indies, the French Indies, and Central America"! (All these three regions collectively do not yield as much indigo as does British India.)

Les Mondes, Revue Hebdomadaire des Sciences.
No. 14, 1882.

Influence of the Coercitive Force upon the Heat produced by Magnetisation.—L. Pilleux.—A fragment of iron which is being magnetised becomes heated in an appreciable manner. The author proves that it is magnetisation and not the induction-currents which heats the iron cores of electro-magnets, and the coercitive force of these cores plays in this case, the same part as the resistance to the passage of electricity when a metal wire is heated by the current of the battery.

Influence of Light upon Grapes.—Dr. A. L. de Villanova.—Grapes exposed to solar light contain more sugar by 3.79 per cent and less acid by 1.23 per cent than such as have remained in darkness.

No. 15, 1882.

Easy Process of Magnetisation.—The so-called method of M. Elias, which has been used by M. Jamin and carefully studied by M. Gauguin, is as follows:—A coil of thick wire is traversed by an intense current; it is composed of 10 to 20 spirals, and is very short in its axial dimension. The plate or rod of steel to be magnetised is passed through it, and a few passes suffice to give saturation.

No. 16, 1882.

The Battery and the Decomposition of Water.—Up to the present day physicists agree that it requires more than 34.5 calories to decompose pure water in a

voltmeter with platinum plates. Thus, a Daniell's element does not produce this decomposition, as it furnishes a tension only equal to 24 to 25 calcs. M. Maiche shows that water can be decomposed by a very feeble battery, such as an iron-copper element, which is figured in *Les Mondes*.

New Improvement in Electric Batteries.—M. Reynier.—This new form of battery is composed of zinc-copper elements depolarised by copper sulphate. It owes its special properties to the use of zinc plates closely partitioned. There is a transformation of copper sulphate into zinc sulphate, whilst zinc is dissolved and metallic copper separated.

No. 17, 1882.

Heat and Magnetisation.—D. Tommasi.—The heating of iron during magnetisation has been pointed out by M. L. Pilleux as well as by the author.

A Little Illusion.—J. Plateau.—This paper, describing an experiment which at first sight seems to realise perpetual motion, cannot be usefully reproduced without the accompanying illustration.

Reduction of Silver Bromide by Light.—D. Tommasi.—It appears from the author's experiments that moist silver bromide loses about 230 per cent of bromine on exposure to the sun. The process is rather a dissociation than a decomposition. A very small quantity of the bromide is dissolved into a basic bromide, and ultimately into free silver and bromine if the exposure is prolonged. The brown bromide of silver contains very variable quantities of bromide, of basic bromide, and of silver.

The Electrolysis of Distilled Water.—D. Tommasi.—Already noticed.

Distribution of Electricity.—A. Hamon.—An account of the system of E. Hospitalier, which requires the three accompanying illustrations.

Annales de la Société des Sciences Industrielles de Lyon.

No. 3, 1881.

This number contains no chemical matter.

MISCELLANEOUS.

Fire Risks of Electric Lighting.—The Society of Telegraph Engineers and of Electricians has appointed a Committee to consider and report upon the rules which they would recommend for adoption for the prevention of fire risks arising from the use of the electric light. The names of the members of the committee are as follows:—Professor W. G. Adams, F.R.S., Sir Charles T. Bright, T. Russell Crompton, M. Inst. C.E., R. E. Crompton, W. Crookes, F.R.S., W. De la Rue, F.R.S., Professor G. C. Foster, F.R.S., E. Graves, Professor D. E. Hughes, F.R.S., W. H. Preece, F.R.S., Alexander Siemens, C. E. Spagnoletti, A. Stroh, Sir William Thomson, F.R.S.

American Association for the Advancement of Science.—The Thirty-first Meeting of the Association will be held at Montreal, Canada, commencing at 10 o'clock, a.m., on Wednesday, the 23rd of August, 1882; under the presidency of J. W. Dawson, LL.D., F.R.S., Principal of McGill University, Montreal. A large local Committee has been formed, and through its several sub-committees is actively engaged in perfecting the local arrangements for the meeting, which will soon be announced by special circular. It is only necessary to state here that the members of the committee are desirous of doing everything in their power to promote the objects of the Association, and that their circular will contain information relating to the local arrangements, hotels and boarding-houses, and the special rates of transportation;

also a general programme for the week. The Headquarters of the Association will be at McGill University, where members will register as soon as possible after arrival. The hotel headquarters will be at the Windsor. The offices of the Local Committee and of the Permanent Secretary will be at the University. The General Sessions and the meetings of the Sections and Committees will all be held in the University buildings. The particular rooms will be designated on the programme for Wednesday. Members expecting to attend the meeting are particularly requested to notify the Local Secretaries at the earliest moment possible. At the Boston meeting several changes in the Constitution were proposed, which were adopted at Cincinnati. As a result of these changes the scope of the Association has been extended, and the sections have been entirely re-organised, so that there are now nine sections of equal standing, each presided over by a Vice-president, and having its own Secretary and Sectional Committee. The new arrangement of the sections is as follows:—

Sec. A.—Mathematics and Astronomy. Sec. B.—Physics. Sec. C.—Chemistry, including its applications to Agriculture and the Arts. Sec. D.—Mechanical Science. Sec. E.—Geology and Geography. Sec. F.—Biology. Sec. G.—Histology and Microscopy. Sec. H.—Anthropology. Sec. I.—Economic Science and Statistics.

All communications relating to the local arrangements for the meeting must be addressed to one of the Honorary Local Secretaries at the rooms of the Natural History Society, University Street, Montreal. All matters relating to membership and to the presentation of papers will be attended to by the Permanent Secretary. The address of the Permanent Secretary will be Salem, Mass., until August 17th; after that time and until the meeting has adjourned, his address will be Windsor Hotel, Montreal, Canada.—F. W. Putnam, Permanent Secretary, Salem, Mass., May, 1882.

Officers of the Montreal Meeting:—

President.—J. W. Dawson, of Montreal.

Vice-Presidents.—A. Mathematics and Astronomy, W. Harkness, of Washington; B. Physics, T. C. Mendenhall, of Columbus; C. Chemistry, H. C. Bolton, of Hartford; D. Mechanical Science, W. P. Trowbridge, of New Haven; E. Geology and Geography, E. T. Cox, of San Francisco; F. Biology, W. H. Dall, of Washington; G. Histology and Microscopy, A. H. Tuttle, of Columbus; H. Anthropology, Daniel Wilson, of Toronto; I. Economic Science and Statistics, E. B. Elliott, of Washington.

Permanent Secretary.—F. W. Putnam, of Cambridge.

General Secretary.—William Saunders, of London, Ontario.

Assistant General Secretary.—J. R. Eastman, of Washington.

Secretaries of the Sections.—A. Mathematics and Astronomy, H. T. Eddy, of Cincinnati; B. Physics, Chas. S. Hastings, of Baltimore; C. Chemistry, Alfred Springer, of Cincinnati; D. Mechanical Science, Chas. B. Dudley, of Altoona; E. Geology and Geography, C. B. Dutton, of Washington; F. Biology, Charles S. Minot, of Boston; G. Histology and Microscopy, Robert Brown, Jr., of Cincinnati; H. Anthropology, Otis T. Mason, of Washington; I. Economic Science and Statistics, F. B. Hough, of Louisville.

Treasurer.—William S. Vaux, of Philadelphia.

Standing Committee.—The Officers above named, and Past Presidents.—James D. Dana, of New Haven; James Hall, of Albany; Stephen Alexander, of Princeton; Isaac Lea, of Philadelphia; F. A. P. Barnard, of New York; J. S. Newberry, of New York; B. A. Gould, of Boston; T. Sterry Hunt, of Montreal; Asa Gray, of Cambridge; J. Lawrence Smith, of Louisville; Joseph Lovering, of Cambridge; John L. LeConte, of Philadelphia; J. E. Hilgard, of Washington; William B. Rogers, of Boston; Simon Newcomb, of Washington; O. C. Marsh, of New Haven; George F. Barker, of Philadelphia; George J. Brush, of New Haven.

NOTES AND QUERIES.

*. Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Soluble Oil.—There is an article used by fishers called "soluble oil," one variety of which seems to consist largely of glycerin; the other is a kind of liquid soap and smells of castor oil. Can any of your readers give me any information as to how these are made?—A FISHMAN.

MEETINGS FOR THE WEEK

- MONDAY, May 22nd.—Society of Arts, 8. "Book Illustration: Old and New" (Cantor Lectures), by J. Comyns Carr.
Geographical, 2. (University).
TUESDAY, 23rd.—Institute of Civil Engineers, 8.
Royal Medical and Chirurgical, 8.30.
Royal Institution, 3. "Digestion," by Professor A. Gamgee.
Society of Arts, 8. "The Gold Fields of West Africa," Capt. Cameron, R.N., and Capt. Richard Burton.
Anthropological Institute, 8. "On Systems of Land Tenure in Different Countries," Sir H. Bartle Frere, G.C.B., F.R.S., &c.
WEDNESDAY, 24th.—Society of Arts, 8. "English and Foreign Technical Education," by E. C. Robins, F.S.A.
Geological, 3.
THURSDAY, 25th.—Royal Institution, 3. "The Metals," by Prof. Dewar.
Royal, 4.30.
Society of Arts, 8. "Recent Passages of Zululand," by Dr. R. J. Mann.
FRIDAY, 26th.—Royal Institution, 8. "Sacred Laws of the Hindus," by Sir Henry S. Maine, at 7.
Quekett Microscopical Club, 8.
SATURDAY, 27th.—Royal Institution, 3. "Poetry and its Literary Forms," Professor D. Masson.

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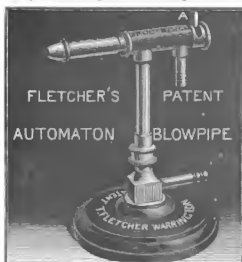
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THE CHEMICAL NEWS.

VOL. XLV. No. 1174.

SOME OF THE DANGEROUS PROPERTIES OF DUSTS.*

By F. A. ABEL, C.B. F.R.S.,
President of the Institute of Chemistry.

(Concluded from p. 215.)

To sum up: it has not been difficult, as will have been seen from the foregoing, to demonstrate experimentally that the existence of a very small proportion of fire-damp in the air of a mine may determine the propagation of flame by coal-dust, ignited by the explosion of some local accumulation of a gas mixture, or by the inflammation of gas suddenly disengaged, or even by the flash from a blown-out shot. It has also been clearly established that in so-called fiery mines the air is never likely to be actually free from fire-damp, and that as much as 2 per cent may exist in the return air of a very efficiently ventilated mine of that class. It must therefore be regarded as a thoroughly well-grounded conclusion that, in many disastrous explosions coal-dust is the chief agent of destruction, and it is indisputable that but few explosions occur of which the effects have not been more or less considerably extended and aggravated by the coal-dust which is raised by the fire-damp explosion. It may also be admitted as not improbable that in some instances the influence of dust may, apart from its combustibility (as described), determine the ignition of a mixture of air and dust with a small proportion of fire-damp by the flame which a blown-out shot, or the accidental ignition of some local accumulation of explosive gas-mixture, has produced. Lastly, it is conceivable, as contended by Freire Marreco, Galloway, and some Continental observers, that a mixture of an inflammable coal-dust and air may even, in the complete absence of fire-damp, both originate and carry on to some distance explosions which, though much inferior in violence to those developed through the agency of gas-mixtures, will be at least equal to them in regard to the disastrous effects on the lives of those exposed to them. That mixtures of coal-dust and air alone may have the power to carry on the explosion originally caused and disseminated by a gas, air, and dust mixture, into regions where no gas whatever exists, will now be generally admitted. The great disturbance of the air which must proceed in immediate advance of the rush of flame produced by the ignition of a mixture of gas and air charged with coal-dust will, in many mine-workings, raise a dense cloud immediately in front of the flame, and the latter will thus be fed as it advances. Mr. Galloway concludes, as the final result of his experiments with coal-dust, that the presence of fire-damp is altogether unnecessary to bring about a coal-mine explosion; but, admitting that the result of certain experiments may seem to favour this conclusion, its realisation necessitates the fulfilment of conditions which cannot but be very exceptional, and its acceptance is certainly unnecessary to add to the formidable character of coal-dust as a source of danger and an agent of destruction in mines.

Whether an explosion originates with, or is chiefly caused by, the production of a mixture of fire-damp with air in such proportions as to be more or less rapidly and violently explosive; whether the originating cause be the reciprocal influence of a small proportion of fire-damp and of coal-dust (or dust of other descriptions of minerals occurring in coal-mines) co-existing in the air of a mine;

whether, possibly, it simply originates with a mixture of very inflammable coal-dust and air in the complete absence of fire-damp; or whether, lastly, only the very limited concession be made that coal-dust will add to the extent, and increase the burning effect, of a fire-damp explosion; in any case, the existence of dust in abundance, and in a dry state, in coal-mine workings, must be recognised as a source of danger not greatly inferior to that caused by local accumulations, or the accidental liberation, of fire-damp. The possibility of dealing with this source of danger should therefore be as much an object of earnest work as has been the improvement of ventilating arrangements for mines.

It being generally impracticable effectually to deal, by actual removal, with the continual accumulation of dust in mine-workings, the only available method of diminishing the dangers arising from its constant production appears to be that of maintaining the floor in the roads, &c., in a damp condition by efficient watering arrangements, almost continually applied. The high temperature of the mine, in many instances, must often render this a difficult and costly process, on account of the rapidity with which the water will evaporate; hence attempts have been made to apply hygroscopic substances (such as calcium chloride, sea-salt, or rock-salt) in conjunction with water, or to use brine, with a view to retard its evaporation, and some successful results appear to have recently attended their application in several districts. In some instances, with improved appliances for the uniform and periodical distribution of sufficient water, the maintenance of mine-roads in a sufficiently damp condition to prevent dust from being raised in any considerable quantity appears to have been accomplished with fair success. There are, however, localities where it is almost impracticable so maintain the floor of the roads in a damp condition, in consequence of the great increase thereby of the tendency to their being gradually raised by the pressure to which they are subject.

Apart from the effects of dust in augmenting the disastrous results of such fire-damp explosions as may arise from the existence of a defective, or an open, safety-lamp in the vicinity of an accumulation of gas, or of a locality where a sudden outburst of gas occurs, the blasting of coal or of rock, in those parts of a mine where fire-damp may exist, if even only in very small quantities, constitutes the chief source of accidents in which coal-dust may have played an important share. There is no doubt, therefore, that the elaboration of really safe methods of getting coal in places where blasting by powder is now resorted to, and of removing the harder rock in the working of drifts where fire-damp may exist, will most importantly contribute towards the diminution of danger arising from the accumulation of dust in mines. The substitution of efficient coal-cutting machines for blasting may to some extent supplant the use of powder, and the employment of compressed air as an agent for bringing down coal or rock has been made the subject of ingenious contrivances, which appear, however, as yet, to labour under some disadvantages in regard to cost, facility of use, and general efficiency. Attempts have been made to render the employment of powder in the presence of fire-damp safe, by using it in conjunction with water. In the first instance it was proposed by Dr. Macnab to bring the latter into direct operation as the cleaving or blasting agent by inserting a cylinder containing water into the blast hole, and connecting it with a very strong external vessel, in which the powder charge was fired, much as the powder charge is fired in the powder chamber of a gun, the generating gas being brought to bear upon the confined column of water, and causing the latter to exert a rending force upon the coal by which it was surrounded. As the results furnished by this method of operation were not promising, the comparatively very simple expedient was resorted to by Dr. Macnab of employing water simply as tamping in a charge hole, a cylinder containing the liquid and of suitable length to fill the hole, being inserted

* A Lecture delivered at the Royal Institution of Great Britain, Friday, April 28, 1882.

over the charge of powder. In the event of a charge blowing out, the dispersion of the water in a very finely-divided condition was relied upon to effect the extinction of the volume of flame which, under these conditions, would be projected into the air of the mine. Some carefully-conducted experiments, with blast holes charged by this method and surrounded by an explosive gas-mixture, showed that occasionally no ignition of the gas resulted from the blowing out of the shot, but that in most instances, the conditions of the experiments being the same, the gas-mixture in front of the blast hole was exploded, when the shot blew out. It is possible that a careful regulation of the charge and length of tamping may render this mode of operation a comparatively safe one, though it may be doubtful whether absolute reliance could be placed upon the invariable extinction of flame in the case of blown-out charges. When the attention of the Royal Commission was directed to the subject of the dangers attending the employment of explosives in coal-mines, it occurred to Mr. Abel to attempt the application to the getting of coal of the principle which he developed some years ago, in the course of his researches on explosive agents, namely, the sudden transmission in all directions of the force exerted instantaneously by a *detonation*, by surrounding the detonating charge with water. It was found in a large number of experiments that when comparatively small charges of gun-cotton or dynamite (the latter being preferable) were enclosed in cylinders of light metal or paper filled with water, and occupying the entire available space (or nearly so) in a blast hole, the detonation of the charge in holes of excessive strength, when employed in proper proportion to the amount of water by which it was surrounded, was always accomplished without ignition of the explosive gas-mixture with which the opening of the blast hole was surrounded. The interesting fact was, moreover, established, by operations carried out in hard coal in Lancashire, that the action of the detonating charge is modified to great advantage, by enclosing the envelope in a long column of water. Instead of exerting a powerfully crushing or disintegrating action, confined within comparatively narrow limits, whereby a charge of gun-cotton or dynamite is rendered of little value as a means of getting coal when used in the ordinary way, the distribution of the explosive force in all directions by the column of water causes it to exert a cleaving or splitting action even superior to that exercised by ordinary blasting powder. The further development of this method of applying detonating agents to blasting purposes in coal-mine workings appears, therefore, well worthy of attention.

Another method of getting coal, which, though not new in itself, has been applied in a novel manner and with most promising results by Messrs. Smith and Moore, has the great advantage of dispensing entirely with the use of explosive agents, and of any but the most simple mechanical appliances.

It consists in applying the force which quicklime will develop if confined, and made to combine under that condition with water, whereby it undergoes very considerable expansion, a large amount of heat being at the same time developed. Messrs. Smith and Moore convert the freshly burned and crushed quicklime into very compact cylindrical masses, or cartridges, having a small groove on one side, so that when the requisite number of cylinders are inserted symmetrically into the mechanically drilled hole in the coal, which they fit accurately, a narrow pipe, with perforations along its entire length, enclosed in a tight-fitting stocking of spent webbing, and provided with a stopcock, may be inserted into the side of the charge, which is afterwards tamped in the usual manner. The proportion of water necessary to slake the lime, plus an excess of about one-sixth, is then forced into the hole through the pipe by means of a simple hand syringe, and the stopcock of the pipe being closed, the operation is complete. In a brief space of time sounds indicative of the cracking of the mass of coal which contains the cartridge show that the expansion of the lime by its union

with the water, and the very considerable development of steam within the cartridges, are performing their work, and after an interval of time varying with the strength of the part of the seam operated upon, the coal is detached in large blocks. The holes can be charged so rapidly that a considerable number may be put into operation in quick succession by one or two men.* As the action of the charge occupies some little time (fifteen or twenty minutes), they really come into operation together, and in this way large faces of hard coal, in long-wall workings, are brought down with ease and certainty. Whether these compressed lime cartridges can be applied with any success in stone still remains to be determined, but in point of cost, simplicity, and above all safety, this method of detaching coal appears to rank before any other yet tried. Besides entirely avoiding the use and production of flame or fire in the blasting of the coal, the operation is conducted gradually and almost noiselessly, and the raising of dust by the more or less violent concussions which attend the employment of explosives in any form or manner is avoided.

It is insisted upon by a great majority of those most competent to judge, that the employment of explosives cannot be dispensed with in the profitable working of coal mines. That the use of gunpowder in the ordinary way, even with strict attention to all practicable precautions, is a most prolific source of accident, has long been recognised. The development of safe methods of applying explosive agents, or of simple and effective substitutes for them, is therefore of such paramount importance in securing protection to the miner against the dangers of fire-damp and of coal-dust, that those who are entrusted with the management of coal mines should spare no exertions to test rigorously but fairly the merits of any proposals which afford promise of success in this direction.

THE DISSOCIATION OF CHLORINE.†

By A. PERCY SMITH, F.I.C., F.C.S., Assistant Chemical Master, Rugby School, and W. B. LOWE, M.A., F.C.S., Storrington.

In the summer of 1879, Meyer showed (CHEMICAL NEWS, vol. xi., p. 49) that when nascent chlorine was heated to a temperature of 1242° to 1567° C., its vapour density was 1.63, or $\frac{1}{2}$ of the vapour-density at 600° . It occurred to one of us that if chlorine was passed through a tube into potassium iodide solution, less iodine might be liberated when the tube was heated than when cold. A trial was made by evolving chlorine from weighed quantities of manganese dioxide and hydrochloric acid, the evolved gas being passed through the stem of a tobacco pipe heated by a combustion furnace. It was found that about one-ninth less iodine was liberated when the tube was heated than when cold. The results were not uniform, owing to the porosity of the tube and presence of aqueous vapour.

At about this time, Meyer's and Züblin's results appeared in CHEMICAL NEWS, vol. xli., p. 135; they, having filled a heated porcelain vessel with chlorine, and displaced it into potassium iodide solution by a current of carbon dioxide, found the vapour-density to be 2.61, hence concluding that free chlorine was not dissociated.

In December, 1881, we submitted the question to further experiment. A U-tube of 55 c.c. capacity was provided with terminal india-rubber tubes closed with

* In one of several operations of this kind recently witnessed by the Lecturer at Shipley Collieries, Derby, in the "deep hard seam," which is nearly 3 ft. thick, ten shots were fired (i.e., watered) together, bringing down a block of coal 20 ft. long by 3 ft. thick and a ft. 10 in. high, weighing about 10 tons. The average time occupied in boring a hole (by mechanical drill), charging and tamping it, and watering the charge, was twenty minutes. The usual operation of bringing down this very hard coal, by wedging, is exceedingly slow and laborious.

† Abstract of a Paper read before the Chemical Society, Feb. 16, 1882.

pinchcocks, which could always be clamped at exactly the same places, thus ensuring a constant volume in each experiment, which volume was 58 c.c. This U-tube was filled with chlorine, by permitting a washed and dried stream of the gas to flow through it at normal pressure. When full both clips were closed simultaneously. One end of this chlorine tube was then connected with a tube of glazed Berlin porcelain, passing through a combustion furnace, and the other end of the porcelain tube with a pair of nitrogen bulbs, containing a solution of potassium iodide, joined on to which was a water pump to exhaust the train of apparatus and draw the chlorine through it. Upon removing the clip between the U-tube and the furnace, and cautiously admitting air by the other clip, the chlorine passed slowly through the bulbs. When no more iodine was liberated, the contents of the bulbs were titrated with sodium thiosulphate. Several experiments were made in this manner without heating the porcelain tube, and in every instance the amount of iodine liberated corresponded to the amount of chlorine used.

| Cl used. | Temp. | I liberated. | Duration of Expt. |
|--------------|-------|--------------|-------------------|
| 0.01838 grm. | 75° | 0.65786 | 5 mins. |

A great number of experiments were then made with the tube heated to various temperatures, from dull redness up to 1030° C., and although less iodine was liberated than with the tube cold, the results were not concordant. The source of error was at length found to be due to insufficient drying of the chlorine (since hydrochloric acid was found in the neck of the first N bulb). Additional precautions were therefore taken in its preparation; the water in the wash bottles was changed each time of using, and extra drying tubes, containing alternate layers of cotton-wool and powdered calcium chloride, added. The air which was drawn through the chlorine tube during the course of an experiment was also first purified by passing through sulphuric acid, potassium hydrate, and over calcium chloride.

The time taken by each experiment varied greatly. If the chlorine was allowed to pass rapidly through the heated tube, more iodine was liberated than when the chlorine passed more slowly and therefore was heated for a longer time. The method which gave the best and most constant results was to keep the clip between the U-tube and the furnace open, and the other clip shut, and only to open it momentarily at intervals. The time taken for all the chlorine to pass through the heated tube was thus about three-quarters of an hour.

When the chlorine was drawn rapidly through the apparatus it was accompanied by a "white smoke," which was insoluble in water, and had no action on litmus paper or on a glowing match. This "smoke" was formed in the porcelain tube, and diminished in quantity as the experiment drew towards a conclusion. The porcelain tube was not acted upon by the chlorine.

In the final experiments, which extended over a long period of time, the "smoke" remained in the porcelain tube (or at any rate was not seen) so long as the chlorine was only permitted to enter in an intermittent manner. When, at the end of the experiment, the clip was opened and air drawn through, the "smoke" appeared in the bulbs, but was of less quantity than in the previous cases. Throughout the experiments the water-pump was kept working, so as to prevent any leakage of chlorine through the joints of the apparatus.

It would be waste of space to give the particulars of all the experiments. The following were results obtained, after eliminating all sources of error:—

| Cl used. | Temp. of Grm. | Tube. | Temp. of Furnace. | Iodine Liberated. | Duration of Expt. |
|----------|---------------|-----------|-------------------|-------------------|-------------------|
| 0.01838 | 75° C. | Porcelain | 1030° | 0.48768 grm. | 30 mins. |
| " | " | " | " | 0.49022 | 55 " |
| " | " | " | " | 0.49149 | 45 " |
| " | " | " | cold | 0.65786 | 5 " |

The mean of these experiments gives the amount of iodine liberated as 0.48799 grm., which corresponds to

0.01369 grm. chlorine; so that 0.01838 grm. Cl at 75° C., becomes 0.01369 grm. Cl at 1030° C., or, as 1 : 0.744.

We forbear to advance any hypothesis to account for this result, but we may call attention to the fact that Meyer found the vapour-density at 1028° C. to be 1.89, which is to the vapour-density at 600° (2.46) as 0.76 : 1.

ON THE PHYSIOLOGICAL ACTIVITY OF SUPER-OXYGENATED MOLECULES, ESPECIALLY THOSE OF QUININE IODATE AND BROMATE.

By CHARLES A. CAMERON, M.D.,
Professor of Chemistry & C.S.I.

THE author has come to the conclusion that the bromates and iodates are physiologically more active than the corresponding bromides and iodides. The facts in support of the theories that physiological activity was proportional to high atomic and molecular weights, and was also due to the unsaturated condition of molecules, were considered and criticised. The facts which supported the theory that unsaturated molecules produced a more powerful action upon the system than saturated molecules were more convincing than the facts upon which the other theories rested. The author considered that the term "super-oxidised" might, for want of a better one, be applied to molecules containing a larger number of oxygen atoms than were requisite to saturate the other atoms present. The iodates, periodates, bromates, and perbromates were composed of super-oxidised molecules. Super-oxidised molecules were perhaps to be properly regarded as unsaturated; their oxygen atoms were as imperfectly saturated as were the carbon atoms in carbon monoxide. In replacing other elements, bromine and iodine invariably act as monads. If they are true monads, then, in such a compound as periodic anhydride, we have two imperfectly satisfied bonds of oxygen—



In the compound KI, each of its two atoms has its unit of equivalence perfectly satisfied by combination with the other atom; the compound is therefore saturated and stable. The addition of four oxygen atoms to KI produces an unsaturated and unstable body, and therefore one likely to be physiologically more active than the stable KI, or KBr, or NaCl.

In 1869 the author introduced the ferric iodate ($\text{Fe}_2\text{I}_2\text{O}_9$) as a substitute for the unstable ferrous iodide, and the therapeutic value of the former seems to have been well established. More than a year ago he also suggested the employment of quinine iodate and bromate. These compounds, especially the former, have been largely prescribed by the medical faculty in Dublin, and have been found of great value in sluggish cases of pulmonary congestion, neuralgia, severe articular pains, malarial enlargement of the spleen, and secondary syphilitic disease. The quinine iodate and bromate have been used chiefly in the form of a granulated effervescent preparation, containing 2 grs. of the quinine salt (a dose) per drachm.

Of iodate of quinine only very meagre accounts are to be met with in chemical books or journals. The author prepared it by neutralising freshly-precipitated quinine hydrate with iodic acid dissolved in not less than 8 parts of water. The iodate forms in exceedingly minute needles of pearly lustre, which at 100° C. become yellowish. Dried at 60°, quinine iodate suffers no loss of weight when kept in *vacuo* over sulphuric acid. The mean result of three determinations showed that it contained 31.8 per

* Abstract of a Paper read before the Medical Society of the College of Physicians, Dublin, May 3, 1882.

cent of iodine. It appears, therefore, to have the following composition: $C_{20}H_{24}N_4O_{12}HIIO_3$. In accordance with this formula the amount of iodine should be 22.92 per cent; the salt was, however, very faintly alkaline from presence of a little free quinine. Quinine iodate dissolves freely in spirit of wine and hydrochloric acid, less freely in ether, and sparingly in strong alcohol and chloroform. It is more or less soluble in all the vegetable acids. 1 part dissolves in 700 parts of cold water; strong sulphuric acid merely colours it a light yellow, and the mixture diluted with water becomes colourless. At $100^\circ C$. it undergoes slight decomposition.

Of quinine bromate no mention can be found in the books or journals. It may be prepared by precipitating barium bromate by quinine sulphate, or by neutralising boric acid with quinine. It forms asbestos-like masses, which under the microscope are found to consist of very long needles. The salt when dry resists the heat of the water-bath, but its solution when evaporated, especially in a platinum dish, leaves a bluish black residue. It is much more soluble than the iodate, namely, to the extent of 1 part in 250 parts of water. Touched with strong sulphuric acid, it detonates, sends off a puff of smoke, and nearly wholly disappears. It is soluble in hydrochloric, acetic, dilute sulphuric, and other acids; also in spirit of wine, and but very sparingly in ether and chloroform.

Shortly after the administration of quinine iodate, both iodic and hydriodic acids are found in the urine; later on the quinine makes its appearance. The continued ebullition of quinine bromate in water causes the solution to acquire a blue colour, exactly like that of indigo. The colour is bleached by nitric acid, but is not affected by dilute sulphuric or hydrochloric acid, or by ammonia.

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

THE following are the relative sensibilities of the principal reactions:—

1. Metallic zinc. One-sixth milligramme of gallium is easily separated without sensible loss from a litre of liquid, even in presence of many foreign substances. At this degree of dilution we are still far from the limit of the sensitiveness of this method. The difficulty of procuring pure zinc unfortunately restricts in practice the use of this metal in delicate analyses.

2. Cupric hydrate.—The same sensitiveness as zinc.

3. Copper and cuprous oxide.—The same exactitude as the two former. Copper and its oxides being easily obtained in a state of purity are to be recommended whenever their use is practicable.

4. Arsenic sulphide.—Very sensitive, but perhaps slightly inferior to the three former reactions. It withdraws the greater part of 1-6th of a milligram of gallium from a litre of liquid.

5. Manganese sulphide.—With 1-6th milligram of gallium per litre we obtain at the end of the operation the ray $G\alpha 417$, but less bright than if we had made use of arsenic sulphide.

6. Potassium ferrocyanide.—1-205,000th of gallium is precipitated and collected upon a filter without sensible loss; we may therefore go further.

7. Boiling after super-saturation with ammonia.—This process gives rise to losses, which seem to range between 1 and 1.5 mgrm. per litre. In a rigorous analysis the ammonia is expelled in the water-bath, or the mixture is boiled in a flask placed in a slanting position to prevent loss by spitting.

8. Carbonate of lime, hot, then ammoniacal ebullition of the hydrochloric solution of the mixture of calcium carbonate and gallium sesquioxide.—The losses, slightly higher than those in the preceding method, rise to 1.5 mgrms. per litre of the original liquid.

9. Calcium carbonate, hot, after reduction of the liquid with sodium sulphite, then ammoniacal ebullition of the hydrochloric solution of the mixture. The loss is about 1.5 mgrms. per litre.

Quantitative Analysis of the Salts of Gallium.

Separation from Cesium, Rubidium, Potassium, Sodium, Lithium, and Ammonium.—When the proportion of gallium is not very small, the simplest method is to super-saturate the hydrochloric solution with ammonia, and to boil until a litmus paper, previously placed in the liquid, takes a distinctly red tint. Water must be added to make up for the loss by evaporation. The gallium oxide is received upon a filter, washed, dried, and ignited. To separate the traces of gallium entangled in a considerable mass of alkaline salts, the boiling solution is treated with cupric hydrate. The mixture of gallium sesquioxide and cupric oxide is re-dissolved in a decided excess of hydrochloric acid; the copper sulphide, which is then thrown down by sulphuretted hydrogen, does not carry gallium with it, and the liquid concentrated to a small bulk is super-saturated with ammonia, and then boiled for a long time.

Separation from the Alkaline Earths.—If the gallium is moderately large in quantity it may be at once precipitated by ammoniacal super-saturation, followed by prolonged boiling; the alkaline earthy oxides remain in solution. Traces of gallium sesquioxide mixed with much of the salts of barium, strontium, or calcium, are separated by means of cupric hydrate. The baryta and the bulk of the strontia and lime may also be precipitated by sulphuric acid from a liquid more or less alcoholic. After evaporation of the alcohol and concentration to a small bulk, the gallium is recovered by ammoniacal ebullition, or by cupric hydrate, according to the degree of exactness required. When the former method has been used the precipitate must be ignited strongly to expel completely any traces of sulphuric acid.

Separation from Magnesia.—Prolonged ebullition of a solution super-saturated with ammonia succeeds well. The process with cupric hydrate is suitable where there are small quantities of gallium along with much magnesia.

Separation from Alumina and Chromic Oxide.—The most convenient process is to precipitate the gallium with ferrocyanide from a very acid hydrochloric solution, containing at least from a fourth to a third of its bulk of concentrated acid. When the gallium is in small proportions (less than 1-100,000th), it must be allowed to stand one day or two days for the precipitate to form. It is then received on a filter, washed with water containing a fourth to a third of its bulk of hydrochloric acid. The filter is dried at a gentle heat and ignited. The result is a mixture of the oxides of gallium and of iron, which are separated, as will be explained in the course of these researches. The almost inevitable formation of a little Prussian blue in the highly acid liquid presents no inconvenience, and merely increases the proportion of ferric oxide to be afterwards separated from the gallium oxide. Ferrocyanide enables us to separate and determine gallium mixed with 2000 times its weight of alumina or chromic oxide. Nevertheless, slight traces of gallium diffused among enormous masses of alumina or chromic oxide, may escape the action of the ferrocyanide. They are collected then by "entanglement in metallic sulphides (those of zinc, arsenic, or manganese) formed in alkaline or acetic solutions." Precipitation with sulphuretted hydrogen in a solution containing ammonium acetate, free acetic acid, and arsenious acid seems preferable. The galliferous arsenic sulphide, previously washed with sulphuretted hydrogen water containing a little acid ammonium acetate, is treated with aqua regia, and evaporated almost to dryness in presence of an excess of hydrochloric acid to expel nitric acid. The arsenic acid is then reduced by sulphurous acid or an alkaline sulphite, diluted with water strongly charged with hydrochloric acid, and treated with sulphuretted hydrogen. The arsenious sulphide precipitated is washed with sulphuretted hydrogen

water containing hydrochloric acid. The gallium remains in the liquid, and is separated by concentration to a small bulk, and boiling after super-saturation with ammonia.—*Comptes Rendus*.

ACTION OF SULPHURETTED HYDROGEN UPON A SOLUTION OF NICKEL SULPHATE IN THE COLD.

By M. H. BAUBIGNY.

On a former occasion the author called attention to the influence exerted by the comparative weights of acetic acid and nickel oxide upon the formation of nickel sulphide when an acid solution of nickel acetate is treated with sulphuretted hydrogen. A fact of the same nature may be verified with nickel sulphate. The results obtained under conditions otherwise alike are independent of the state of concentration of the metallic solution.

With zinc, as is said by Berzelius, and as the author has verified, the precipitation ceases when the liquid becomes acid up to a certain point. With nickel nothing of the kind occurs, and hence the quantity of nickel sulphide formed by sulphuretted hydrogen is a function of the duration of the experiment.

These results are independent of the state of saturation of the solution by the sulphuretted hydrogen gas, for the precipitation presents the same properties if the metallic solution is saturated at 0°, or at 30°, at which latter temperature the solubility of sulphuretted hydrogen in water is about half what it is in the same liquid at 0°. The precipitation is merely less rapid.

As the weight of nickel sulphide formed increases with the duration of the experiment, it results that the quantity of sulphuric acid set at liberty increases also, and as the reaction takes place, other things being equal, with a dilute or concentrated solution of nickel sulphide, we may believe that the formation of the sulphide is always independent of the weight of the free acid to the weight of the undecomposed sulphate. The foregoing observations, if thus interpreted, do not lead to an exact conclusion, for this progressive precipitation of the sulphide under the conditions laid down above is only due to a secondary reaction in which the nickel sulphide formed intervenes by forming a hydrosulphate of the sulphide.

The action of the sulphuretted hydrogen under the above conditions is annulled as soon as the solution contains free sulphuric acid equal in weight to one-fourth of the acid of the salt.

The formation of nickel sulphide by sulphuretted hydrogen and nickel oxide is a function of the ratio of the weights of the acid and of the metal present, and not of the relative acidity of the liquid, i.e., the weight ratio of the free acid and of the water.

There is in this fact a lesson of great analytical importance from which the author has derived advantage for more than three years in the separation of nickel and zinc. For zinc, as will be shown on a future occasion, the precipitation of the sulphide is a function of the relative acidity of the liquid and not of the relative weights of acid and metal present, so that by diluting the solution of zinc in proportion to the quantity of free acid, it may be precipitated as sulphide entirely and alone.—*Comptes Rendus*.

Detection of Alkalies in Silver Nitrate.—M. Stolba. —The salt is dissolved in the smallest possible quantity of water; the liquid is filtered, and hydrofluosilicic acid is added drop by drop. If this produces a turbidity, an alkaline salt is present. If the liquid remains limpid, it is mixed with an equal volume of alcohol, which will precipitate the slightest traces of alkali if present.—*Journal de Pharmacie et de Chimie*.

A NEW REAGENT FOR NITROUS ACID.

By Dr. A. JORISSEN.

If nitrous acid is allowed to act upon an alcoholic solution of rosaniline, the liquid, according to Max Vogel, is coloured at first a splendid violet, then a fine blue, which passes into a dark green, then into a yellowish green, and ultimately into a reddish yellow.

Although other chemists who have been engaged with researches on the constitution of rosaniline have made similar observations to those of Vogel, it does not appear that anyone has proposed to apply this reaction to the detection of nitrous acid. Rosaniline may, however, be used for the detection of traces of nitrous acid, but it is advisable to use a solution in glacial acetic acid in preference to one in alcohol.

If we dissolve 0.01 grm. magenta in 100 c.c. glacial acetic acid, and if 2 c.c. of this solution are placed in a small porcelain capsule, and a trace of solid potassium nitrite be added, the phenomena described by Vogel may be observed. The liquid turns successively violet, blue, green, and finally yellow. The nitrates are without action upon the reagent. If there be added to the test-liquid free mineral acids, the mixture takes finally a yellow colour, but this is due to the formation of a tri-acid salt of rosaniline, and the characteristic red colour of rosaniline can be reproduced by the addition of water. When the change of colour has been occasioned by nitrous acid the original colour cannot be restored by the addition of water, but the liquid remains yellow.

If it is desired to detect a nitrite in a liquid it is concentrated, or by preference evaporated to dryness. When cold a suitable quantity of the reagent is added, when the characteristic play of colours is produced if a nitrite be present. The evaporation to dryness serves to render the reaction more sensitive, as it succeeds better the more concentrated the acetic acid.

In searching for minute traces of nitrous acid the quantity of magenta dissolved in the glacial acid may be proportionally decreased by, e.g., mixing 1 c.c. of the reagent as described above with 9 c.c. of glacial acetic acid.

The author has shown experimentally that the new reagent may be used for the detection of nitrous acid in natural waters in Fresenius's method of distilling with glacial acetic acid. For this purpose 1 c.c. of a solution of 0.5 grm. potassium nitrite in 1 litre of water was added to 100 c.c. of water. This liquid, which contained 0.005 grm. of the nitrite, was mixed with acetic acid and introduced into a small retort connected with a receiver containing a mixture of 9 c.c. glacial acetic acid and 1 c.c. of the test liquid (the solution of 0.01 grm. magenta in 100 c.c. glacial acetic acid). A few drops of the distillate sufficed to produce the above-described change of colours in the receiver.—*Zeitschrift für Analytische Chemie*.

A RECLAMATION.

On p. 50 of our present volume we inserted, under the title of "A Chemical Anomaly," a short article translated from the *Revue Scientifique* and *Les Mondes*. In this article the possibility of a certain variability of the atomic weights, or at any rate of the composition of certain compounds, is represented as a suggestion of M. Schützenberger. We have now received a courteous communication from Professor Boutlerow, of St. Petersburg, in which he claims this idea as originally his, and as having been made public in a communication to the Russian Chemical Society more than a year ago. Whilst we have pleasure in inserting this announcement, we do not, of course, desire to make any imputation upon M. Schützenberger, who may have arrived independently at results similar to those of Professor Boutlerow.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 18, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

The following certificates were read for the first time:—
J. J. Dobbie, B. Brauer.

The President then called upon Dr. MILLS to read a paper "On the Precipitation of the Alums by Sodid Carbonate," by E. J. MILLS and R. L. BARR. A solution of pure potassio-aluminic alum was prepared, containing 1 per cent of aluminic sulphate, and a solution of pure sodium carbonate containing 0.93038 per cent. The strengths of equal volumes of these solutions would be $\text{Al}_2(\text{SO}_4)_3 : 3\text{Na}_2\text{CO}_3$. The required quantity of sodium carbonate solution having been placed in a beaker, water was added to 100 c.c., and then 100 c.c. of the alum solution. The whole was mixed, care being taken to keep the temperature constant, and left for an hour; the precipitate was then quickly filtered off and weighed. In this way tables and curves were obtained, giving the precipitation with varying quantities of sodium carbonate. The alum solution begins to yield a precipitate when the ratio is about $\text{Al}_2(\text{SO}_4)_3 : 1\frac{1}{2}\text{Na}_2\text{CO}_3$. It is about half precipitated with $\text{Al}_2(\text{SO}_4)_3 : 1\frac{1}{2}\text{Na}_2\text{CO}_3$, and completely precipitated in the proportion $\text{Al}_2(\text{SO}_4)_3 : 1\frac{1}{2}\text{Na}_2\text{CO}_3$. The precipitation takes place in three stages. In the first, 19 c.c. of sodium carbonate are added, and no precipitation takes place; in the second, a continuous precipitation takes place until about half the alum is thrown down, 47 c.c. of sodium carbonate being required. In the third the precipitation proceeds, but with altered constants, and 80 c.c. of sodium carbonate are needed. Similar results were obtained when potassio-chromic alum was used, the three stages being $\text{Cr}_2(\text{SO}_4)_3 : 2\text{Na}_2\text{CO}_3$; $\text{Cr}_2(\text{SO}_4)_3 : 1\frac{1}{2}\text{Na}_2\text{CO}_3$; the limit of complete precipitation was not determined.

Mr. W. H. PERKIN then read a paper "On Rotary Polarisation by Chemical Substances under Magnetic Influence." So far as this subject has been studied by De la Rive, Becquerel, &c., no definite relationship between the chemical composition of substances and their power of rotating the plane of polarisation, when under the influence of magnetism, has been observed. The object of the author was to discover, if possible, whether any relationship of this kind existed. The apparatus used was similar to that employed by Becquerel, the liquids being placed in tubes closed at their ends with glass plates. The ends of the tubes were inserted a short distance into perforations in the armatures. Water and carbon disulphide were used as standards. The author's results, which were calculated for unit lengths of the fluids, agreed pretty closely with those of De la Rive and Becquerel, but seemed to bear no relationship to chemical composition. On consideration it seemed probable that unit lengths of vapours would give better results. It was soon apparent that the direct estimation would be attended with too many difficulties. The results of the observations obtained with unit lengths of liquids, which would be referred to the lengths of columns of liquids, which would be formed by the condensation of unit columns of their vapours; in other words, to lengths related to each other in proportion to their molecular weight, making the necessary correction for difference of densities. This can be done by the simple equation—

$$\frac{r \times m w}{d}$$

r being the observed rotation, $m w$ the molecular weight, and d the density. Having made this calculation for the substance under examination, and for the standard with which it is compared, the molecular coefficient of magnetic rotation, or, more briefly, the molecular rotatory

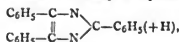
power, can be obtained by dividing the former by the latter. The numbers thus calculated clearly indicate that the molecular magnetic rotatory power follows the chemical composition. Thus:—

| | M. R. P. | Difference for CH_4 |
|---------------------|----------|------------------------------|
| Water.. .. | 1'00 | |
| Methyl iodide | 9'07 | 1'12 |
| Ethyl " | 10'19 | 1'20 |
| Propyl " | 11'39 | 2'0 |
| Amyl " | 13'4 | |
| Methyl alcohol.. .. | 1'62 | 1'06 |
| Ethyl " | 2'68 | 1'06 |
| Propyl " | 3'74 | 1'14 |
| Butyl " | 4'88 | 1'12 |
| Amyl " | 6'00 | |

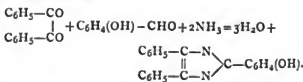
A specimen of amylene, C_5H_{10} , gave the number 5.7, which is very nearly 5.5 (5×1.1). Isomeric and metameric bodies show slight differences. The author promises further researches in the aromatic series, and as to the effect of isomerism.

Dr. MILLS was much interested in the paper, from a theoretical point of view. He would suggest the determination of the magnetic rotatory power of some of the higher members of the series. In several cases a value seemed to be indicated for CH_2 in the lower members of a series which was not confirmed by determinations made with the higher members of the series.

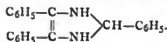
Dr. JAPP then read a paper "On the Constitution of Amarine and Lopine," by F. R. JAPP and H. H. ROBINSON. Amarine, $\text{C}_{21}\text{H}_{18}\text{N}_2$, was prepared by Laurent by saturating an alcoholic solution of benzaldehyde with ammonia. Fownes prepared this substance by boiling the isomeric hydro-benzamide with caustic potash. Lopine, $\text{C}_{21}\text{H}_{16}\text{N}_2$, was obtained by Fownes by the destructive distillation of amarine, and by Laurent in the destructive distillation of hydro-benzamide. Fischer and Troschke (*Ber.*, 13, 706), from various considerations, assign to lopine the formula,



but state that the existing experimental material affords no safe criterion for the position of the last hydrogen atom, nor the arrangement of the remaining bonds in the ring. Now there is an unmistakable resemblance between the above partially-developed formula and the formulae of the compounds recently obtained by one of the authors (in conjunction with W. Sreatfield) by the action of hydroxy-aldehyds and ammonia upon phenanthraquinone. It appeared to the authors, therefore, that by the action of para-hydroxy-benzaldehyd on benzol in the presence of ammonia, hydroxylophin ought to be obtained by this equation:—

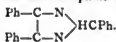


On trying this reaction, hydroxylophin was obtained, and by distillation with zinc dust furnished lopine, identical in every respect with that obtained by Laurent, Fownes, &c. Lopine therefore belongs to the class of Hühner's anhydro-basides, and would be named anhydro-benzoyl-diamido-stilbene. The authors assign to amarine the formula—



The authors hope by extending the above reaction to prepare fresh analogues of lopine.

Dr. ARMSTRONG suggested another method of completing Fischer's formula for lophine—



Dr. JAFFE could not agree with this formula, because, besides the introduction of dyad hydrogen and triad carbon, it did not explain the formation of the diethyl-lophinium iodide prepared by Kühn (*Ann.*, 122, 327).

After the thanks of the meeting had been given to the authors for their respective papers, the Society adjourned to June 1st, when a paper will be read "On the Spectroscopic Study of Chlorophyll," by Drs. Russell and Lapraik.

PHYSICAL SOCIETY.

Saturday, May 20th, 1882:

Professor FULLER in the Chair.

PROF. W. CHANDLER ROBERTS, F.R.S., communicated the results he had obtained in repeating the experiments of M. W. Spring, Professor at the University of Liège, on the union of finely-divided particles of metal by pressure. M. Spring had shown that at a pressure varying from 5000 to 7500 atmospheres, metallic filings may be united into coherent discs. Thus, at a pressure of 6000 atmospheres bismuth filings may be united into a disc, which has a crystalline fracture and a density which is identical with that of the metal cooled from the molten state. Zinc, again, also a very crystalline metal, will weld into a disc at a pressure of 7000 atmospheres, and the metal will even "flow" into cracks between the die and the collar surrounding it, just as in the experiments of M. Tresca, lead "flowed" under similar circumstances. Prof. Roberts had repeated and confirmed many of the experiments of M. Spring, whose more recent results are of special interest, as he has shown that if filings of bismuth, lead, and cadmium be mixed in suitable proportions—such, for instance, as in Wood's alloy—and if the mixture be submitted to a pressure of 7500 atmospheres, an alloy is obtained which will actually fuse at 70° C., the true fusing-point of Wood's alloy being 63° C. Prof. Roberts showed to the Society an alloy he had prepared which melted below 100° C., although of the constituent metals the lowest melting-point is 230° C., and he pointed out the great interest, both to the physicist and metallurgist, of M. Spring's results.

Mr. WALTER BAILY then showed mathematically that the repulsion between the magnet and revolving copper disc in the experiment shown by Prof. Guthrie at the last meeting of the Society, ought to vary as the square of the velocity of rotation of the disc, a result which Prof. Guthrie had found.

Mr. LUCKY gave the results of tests of Mr. Bennett's cell (described at the last meeting) made by Prof. Guthrie. The electromotive force was 1.14 volts, the internal resistance 0.8 ohm, but both quantities vary under certain conditions.

Prof. MACLEOD also gave the results of tests made by him. These show that the cell rose in E.M.F. from 1.005 volts on charging to 1.213 volts after standing three days. The internal resistance was then 1.007 ohms. Both quantities varied under different conditions of working.

Mr. C. V. BOYS then exhibited an improved form of his vibratory meter for measuring electric currents, and specially designed for electric lighting purposes. He has applied to the form formerly shown to the Society the contact-making device employed in Hipp's electric clocks, which though imperfectly adaptable to the clocks is perfectly adaptable to the meter. The force is proportional to the displacement. No sliding contacts are employed. Mr. Boys also explained some other plans for current

meters, one of which he believes to be the final form for practice, and which, besides being remarkably simple in construction, is free from the objection of being tampered with by means of extraneous magnets. In reply to Prof. Foster, he stated that self-induction does not disturb their action.

NOTICES OF BOOKS.

Foods: their Composition and Analysis. A Manual for the Use of Analytical Chemists and others. With an Introductory Essay on the History of Adulteration. By A. WYNTER BLYTH, M.R.C.S., F.C.S., &c. London: C. Griffin and Co.

The work before us is a portion of the second edition of the author's "Manual of Practical Chemistry." The second, or toxicological portion, will appear separately under the title of "Poisons: their Effects and Detection." The present volume, though covering the same ground as the division "Foods" in the former edition, is substantially a new work. It has been thoroughly revised, enlarged, and in part re-written, and now forms an admirable digest of the most recent state of knowledge on the detection of the various impurities and sophistications to which articles of food are unfortunately liable.

Mr. Blyth opens his work with a history of adulterations, of the laws for their repression, and of the chemical and microscopical means for their recognition. There is a useful summary of the present English law on the subject, with its loopholes and the quibbles of which offenders or their legal advisers have availed themselves, too often with success.

An introductory chapter to Part II. is devoted to an account of certain special forms of apparatus used in food analysis, and not figured or described in the ordinary chemical manuals. Amongst these are Soxhlet's apparatus for treating substances with solvents; Clausenier's modification of the same appliance for smaller quantities; the author's own arrangement for extraction with ether, petroleum, &c.; Jolly's spiral balance, and the exhausting apparatus used by the Swan Electric Light Company. The microscope, micro-chemical research, the micro-spectroscope, and micro-photography are next described. The detection of colouring matters as applied to articles of food and drink is very carefully discussed. The determination of the ash of organic matter is next considered, and several possible sources of error are pointed out.

After these preliminary instructions the author passes on to a systematic review of the various articles of food, the special frauds to which each is liable, and the best methods used for its detection. Under sugar he remarks that loaf sugar is, as a rule, chemically pure, and that the adulterations enumerated as occurring in raw sugars represent "more what is possible than what actually exists." There is reason, however, to fear that depraved ingenuity, stimulated by the necessity of finding a market for the ever-increasing production of starch-sugar, will find out novel means of incorporating this inferior product with saccharose. A comparative analysis given of the respective ashes of cane- and beet-sugars shows some interesting points. The ash of cane-sugar is poorer in alkaline matter, and shows merely 0.87 per cent of soda as against 1.12 per cent in beetroot-sugar. Under the colouring matters likely to be met with in sweetmeats we meet with one with which we are not acquainted, to wit, "saffron blue." We also find safflower classed among yellow colouring matters. Now although safflower does contain two yellow colouring principles, we never knew them put to any practical use, as better yellow colouring matters are abundant.

Honey is now very extensively forged, even to the extent of spurious combs made of paraffin. Mr. Blyth

recommends an examination of the comb with warm sulphuric acid, which attacks and blackens the bees'-wax, whilst it is without action upon paraffin. A microscopic examination of spurious honey shows the absence of grains of pollen.

Jams are pronounced, with truth, to be extensively adulterated. Indeed, there are said to be jams in the market which contain not a particle of fruit. The author recommends a microscopic examination of the tissues, seeds, &c., and a spectroscopic examination of the colouring matters.

Vogel's table for the diagnosis of starches is here inserted, and will be found exceedingly useful in determining a variety of vegetable bodies.

Under wheat we find mention of the important fact that a determination of its nitrogen by combustion by no means shows its comparative dietetic value, or, indeed, that of barley and oats, &c. Much of the nitrogen present in the outer layers of the grain does not occur as albumenoid matter, but as nitric and nitrous acids, and alkaloids not assimilable by the human system. Hence the movement for the use of bread made of the entire grain lacks a scientific basis.

Instructions are given for the detection of the seeds of corn-cockle (*Agrostemma cithago*), of darnel (*Lolium temulentum*), and of the ergot. These substances are, of course, never intentionally mixed with grain, but they may be accidentally present, and in case of unaccountable sickness breaking out among the consumers of some particular make of bread they should be sought for. A curious fact, not generally known, is that fresh bread contains on an average 0.313 per cent of alcohol, and that 0.132 to 0.120 per cent may be found even in samples a week old.

The "Farinaceous Foods," so commonly used as foods for young children, are rightly condemned as consisting mainly of starchy and saccharine matter, which the child is unable to assimilate, and is in consequence literally starved. A medical friend informs us that he has been frequently consulted when the injury done in this manner has been irremediable. Mr. Blyth rightly remarks that a child at the breast is more of a carnivorous than of an omnivorous animal, and will digest meat-broth, meat, and albuminous fluids with ease, whilst it is unable to assimilate the farinaceæ. The same rule holds good with many animal species. Thus most of our fruit- and grain-eating birds when in the nest require and receive a purely animal diet. It is to be regretted that the author makes no mention of the corn-flours which generally consist of the meal of some kind of grain deprived of its albumenoid, saccharine, and fatty matters—in other words, of its most valuable constituents—and yet finding a readier sale than the material of which it may be considered the inferior portion.

Mention is made of a peculiar poisonous principle sometimes developed in pears. In a case of this kind, which occurred some little time ago in Salford, many persons exhibited the symptoms of an irritant poison, though neither arsenic, copper, lead, &c., could be detected. The compound produced may possibly be analogous to the ptomaines.

Turning to milk, we find that the author's own experiments confirm the view of Wanklyn, Carter Bell, and others, that the true lowest percentage of milk solids, minus fat, is a little above rather than below 9. Mr. Blyth speaks here of a fact little known, that the pigeon for a little time after her young are hatched secretes in her crop a peculiar albuminous fluid, supposed to serve for the food of the nestlings. In determining the total solids of milk it appears that the results when platinum capsules are used are more constant and lower than in case of porcelain or glass vessels. Diseased milks, the author considers, can only be detected by biological methods. Milk, he states, contains all that is necessary for the nourishment and growth of disease-symptoms.

Space does not allow us to proceed further with our

examination of this excellent work. We can confidently recommend it to analytical chemists and to the medical profession, and even the educated part of the lay public will find in it much instructive and by no means unpleasant reading.

OBITUARY.

MR. DUGALD CAMPBELL.

MR. DUGALD CAMPBELL, of Quality Court, Chancery Lane, who has long been known as an analytical chemist, died at his house in Holland Road, Kensington, on the 12th inst., at the age of 64. Mr. Campbell was born in Scotland, and was connected with some of the best Scottish families. In his youth he went to Australia, and on his return to this country commenced the study of chemistry under Professor Graham, at University College, where he subsequently held the post of Demonstrator of Chemistry for a few years. Whilst filling that position he published ('n 1869) his "Practical Text-book of Inorganic Chemistry," which enjoyed a considerable amount of repute in its day. Very early in his career he commenced to pay attention to the subject of water analysis, and he assisted Professor Clark, of Aberdeen, in his experiments on the process of water-purification, with which his name is associated. Mr. Campbell has long been regarded as a great authority on water, sewage, &c., and was largely consulted by sanitary authorities and the promoters of water-works. Although he never held any formal appointment under Government, he was frequently consulted by the Inland Revenue Department on questions of adulteration. Many years ago he undertook, in conjunction with Professor Graham and Dr. Stenhouse, an elaborate series of researches with reference to the adulteration of coffee, the results of which appeared in the Chemical Society's *Journal*, to which he also contributed papers "On the Application of Sewage to Agriculture," and "On the Source of the Water in the Deep Wells of the Chalk under London;" a short article "On the Presence of Arsenic in River Sand," in the *Philosophical Magazine*, and a paper "On the Effect of Magnesia on the Soap Test," which was read before the British Association in 1851, completes the number of his published researches, so far as we are aware. Some years ago he served on the Council of the Chemical Society, and he also belonged to the Council of the Institute of Chemistry. The appointment of Chemist to Brompton Hospital was also held by him. Mr. Campbell was entrusted by the Commissioners of Patents with the preparation of several volumes of their "Abridgments," amongst which may be mentioned those relating to "India-rubber and Gutta Percha," "Gas," "Medicine," "Oils, Fats, and Candles," "Acids, Alkalies, and Salts," and "Sugar." He was well known in the law courts as a scientific witness, and his analyses were made with so much care, and his evidence was given in such a cautious and guarded manner—in this respect he was a thorough Scotchman—that he was rarely shaken in cross examination. For many years, and up to the time of his death, he was largely indebted to the skill of his Assistant, Mr. H. R. Gregory. Mr. Campbell's health had been in a precarious state for some months, the proximate of his death being an attack of paralysis. He was buried at Brompton Cemetery on Tuesday last.

Researches on the Form in which Nitrogen is to be given to Crops.—Dr. E. Wien.—The plants experimented upon (oats, peas, broad beans, and soja beans) all prefer saltpetre to ammonia. The author recommends saltpetre as preferable to ammonium sulphate for mixing with phosphates.—*Biedermann's Centralblatt*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 18, May 1, 1882.

Certain Reactions of Mercuric Chloride.—H. Debray.—The author has for some time employed calomel for precipitating palladium and platinum in the metallic state from the solutions of their chlorides. The calomel passes into the condition of mercuric chloride, whilst iridium, ruthenium, and rhodium remain as sesquichlorides. The advantages or defects of this method of separating the platinum metals will be the subject of a future communication. The author at present merely points out certain reactions of mercuric chloride in presence of ammonium hydrochlorate or the alkaline chlorides. Mercuric chloride is known to be reduced to the insoluble mercurous salt by a solution of sulphurous acid. This reaction is accelerated by heat, and is very rapid at a temperature bordering upon ebullition. It is no longer the case if the solution contains an excess of sodium chloride (twenty times the weight of the mercuric chloride or upwards). On boiling and adding sulphurous acid to any extent, there is no precipitate of calomel. The hypothesis that mercuric chloride by combining with the alkaline chlorides is inadmissible, according to the recent thermo-chemical investigations of M. Berthelot. The precipitation of mercuric acid by potassa or soda in presence of a large excess of an alkaline chloride presents other interesting features. If a soluble alkali is poured little by little into a solution of mercuric chloride, there is formed a precipitate of variable colour, from yellow to black, especially on heating the liquor. This depends on the formation of oxychlorides, of compositions varying with the proportions of the soluble chloride and of the alkali employed. If the alkali is in excess, all the oxychlorides are destroyed, and we obtain the ordinary yellow precipitate of mercuric oxide. The presence of a large excess of sodium chloride hinders the production of these intermediate compounds. The addition of an alkali to such a solution does not cause an immediate precipitate, even if it is in excess, but after a few moments the oxide is deposited of a crystalline appearance, and more dense than that usually obtained by precipitation. If the liquids are cold, it is yellow, but if precipitated at the boiling-point it is red, approaching the oxide obtained by calcining the nitrate. Like the latter, the precipitated red oxide is not attacked by dark chlorine; the crystalline yellow oxide is slightly attacked by chlorine, but much more slowly than the ordinary amorphous oxide.

Use of Liquefied Gases and especially Ethylene for the Production of Low Temperatures.—L. Cailletet.—Liquefied ethylene boiling at the atmospheric pressure can produce a cold more intense than has been hitherto realised. It has, further, the property of remaining liquid and transparent at temperatures where nitrous oxide and carbonic acid become opaque. The author hopes that by condensing gases less easily liquefiable than ethylene, he may obtain still lower temperatures.

Separation of Gallium.—Lecoq de Boisbrander.—See p. 228.

Polarisation of Electrodes and Conductivity of Liquids.—E. Bouty.—Whatever is the electromotive force of the battery, the polarisation of each of the electrodes is at first inferior to any measurable quantity; it attains its limit in a few minutes at the negative electrode, where it is weaker, and only in some hours at the positive electrode, where it is stronger. In any case it is the result of the passage of a current, which traverses at first the voltmeter with the full intensity determined by

the electromotive force and the resistance employed, but which grows progressively weaker as the alteration of the surfaces of contact of the electrodes and of the liquid gives rise to polarisation. A liquid has only one method of conducting electricity, whatever may be the particular phenomena of which the electrodes are the seat.

Influence of a Metal upon the Nature of the Surface of another Metal placed at a very Small Distance.—H. Pellat.—If two metallic surfaces are placed parallel to and at a little distance from each other (a few millimetres or a few tenths of a millimetre), each metal has generally undergone a slight change in the properties of its superficial layer, due to the neighbourhood of the other metal, and depending upon the nature of the latter. This change requires a few minutes for its production, increases with time, but tends towards a limit. When the influencing metal is removed, the one influenced returns by degrees and spontaneously to its original state. The phenomenon was detected by measuring the differences of potential that exist between the electric strata which cover the surfaces of two metals in contact. Amongst the influencing metals, lead and iron produce the most considerable effects; copper, gold, and platinum give a distinct effect; zinc does not appear to modify a metallic surface placed near it. The phenomenon observed, though detected and studied electrically, is not of an electric character. It is a purely material action depending essentially on the nature of the influencing metal, and being great with lead, less with copper, and nil with zinc. It appears as if metals gave off, at common temperatures, a volatile substance, which, when deposited upon the surface of objects, modifies their chemical nature. The author believes that this phenomenon approaches the images of Möser, and is connected with the fact that several metals have a slight odour.

Liquefaction of Ozone.—P. Hautefeuille and J. Chappuis.—The authors have obtained ozone in liquid drops of a deep indigo-blue; this liquid has been preserved for nearly thirty minutes under a pressure of 75 atmospheres, and its evaporation is not very rapid, even under the atmospheric pressure. The liquefaction was obtained by compressing a mixture of oxygen and ozone contained in the cylinder of M. Cailletet's apparatus.

Action of Insoluble Metallic Sulphides upon a Solution of Acid Nickel Sulphide in Presence of Sulphuretted Hydrogen.—H. Baubigny.—This memoir will be inserted at length.

Oxidation of Pyrogallol in Presence of Gum Arabic.—Ph. de Clermont and P. Chautard.—The authors, following the indications of H. Struve, obtain purpurogalline by causing aqueous solutions of gum arabic to react upon pyrogallol acid, likewise dissolved in water. They dissolve 10 grms. pyrogallol acid in a little water, and add to the solution 500 c.c. of a solution of gum at one-tenth. The whole is introduced into a wide flask containing 2 litres. In a few moments the mixture becomes pale yellow, and shortly afterwards brown. After some hours the purpurogalline begins to be precipitated; the deposit increases daily, and in two months the operation is terminated. They add then an excess of water to remove the gum; the precipitate is let settle, and washed several times by decantation, and then filtered. The purpurogallin is thus obtained in crystalline needles of a fine golden-yellow, which are freed from traces of gum by being dissolved two or three times in alcohol.

Chemical Study of Various Products of Uruguay.—M. Sacc.—The products in question are caoutchouc, the camphor tree, a vetch with blue flowers, and an *Alsine*.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 3.

Composition and Use of Peat Litter.—Prof. J. König.—Peat litter, *i. e.*, the fibrous upper layer of peat,

is poorer than straw in potash, phosphoric acid, and lime, but richer in nitrogen. Their agricultural value is about equal. The peat has a greater power of retaining ammonia.

Grandeau's Theory on the Fertility of Soils applied to Different Soils, with Especial Reference to their Valuation.—C. F. A. Tuxen.—The author comes to the conclusion that Grandeau's theory, though it enables us to recognise important relations in the soil, does not possess the universal validity needed for ascertaining the fertility of the soil. Neither the determination of the *matière noire* nor that of its phosphoric acid gave results from which conclusions could be formed as to the fertility of the samples.

The Utilisation of the Residue of Molasses and the Products formed on its Dry Distillation.—MM. Ernst, Brosche, Oppermann, &c.—The products obtained are potash, ammonium sulphate, methylic alcohol, tarry oils, and resin.

Reverted Nitrogen.—H. Pellet.—Of the nitrogen of dried blood about 50 per cent is soluble in water, but only small quantities of that present in powdered leather. The degree of solubility of the nitrogen present in a manurial agent may give a standard for its agricultural value. On treating wool, silk, &c., with steam under pressure, and evaporating the liquid, there is obtained a manure, azotine, a matter containing from 11 to 14 per cent of nitrogen, completely soluble in water. If mixed with superphosphate the nitrogen becomes insoluble.

Experiments with Phosphoric Acid in Different Forms.—Prof. Krockner and Dr. H. Grahl.—Bone-dust in conjunction with ammonium sulphate gave the highest result. Precipitated phosphoric acid, whether with or without ammonium sulphate, gave better results than either reverted or soluble phosphoric acid under the same conditions.

Manuring with Kainite or Moorland Meadow.—Prof. M. Maercker.—Of the mixtures tried, 1 part superphosphate with 3 parts kainite was the only one which proved remunerative.

Journal de Pharmacie et de Chimie.
May, 1882.

"Diainfection" of Commercial Alcohol.—A. Riche.—This memoir has been going the round of the press, and has been already noticed in the *CHEMICAL NEWS*.

New Researches on the Water of Schinznach.—MM. Oberlin and Schlagdenhauffen.—A paper of specially pharmaceutical interest.

Detection of "Denaturated" Alcohol.—P. Cazeneuve.—The author uses potassium permanganate, which reacts upon the acetone invariably present in methylated spirit.

Note on the Tincture of Iodine.—J. Castelha.—The author adds potassium iodate to prevent the gradual alteration of this tincture.

The Best Process for Determining the Cinchona Alkaloids.—Dr. J. E. de Vrij.—The author recommends the process of Proliis, which consists in the use of the following liquid for extracting the bark:—Ether, 88 parts; liquid ammonia, 4 parts; alcohol, at 92° to 96° per cent, 8 parts.

Production of Carbon Oxy-chloride in Chloroform.—J. Regnaud.—Carbon oxy-chloride which results from the decomposition of chloroform exposed to the air and the sun's rays is the most dangerous impurity in this anesthetic. It is produced when a mixture of the vapour of chloroform and of air is exposed to the sparks of a Ruhmkorff's coil, or to the effluve, or when the vapour of chloroform comes in contact with ozonised air.

Safety-tube for Gas Generators.—F. Bellamy.—The apparatus cannot be described intelligibly without the accompanying figures.

Detection of Iron in Urine.—M. Quillart.—The author destroys the organic matter by means of pure sulphuric acid. The ash, when cold, is treated with nitric acid to peroxidise the iron. It is then evaporated to dryness at a gentle heat; the residue is taken up with distilled water acidulated with a drop of nitric acid, and the liquid thus obtained is treated with the ordinary reagents for iron.

Rouge Végétal.—MM. Guichard and C. Thomas.—Rouge végétal, or Rouge de Bordeaux, is a colour much used in sophisticating wines. It is an azo-dye, the so-called Bordeaux manufactured by the Hoechst Aniline Works. M. Thomas, to detect this colour, dyes silk with the wine. A genuine red wine dyes silk a violet or lilac, which, on the addition of a few drops of ammonia, takes a greenish tint. Wines coloured with Rouge végétal dye silk a garnet red, which is darkened by ammonia and turned more to a brown. As a further test, he drops a portion of the wine upon chalk moistened with solution of alum. Natural wines stain the chalk a violet-grey; wines coloured with the dye in question give decided red spots.

MEETINGS FOR THE WEEK.

TUESDAY, 30th.—Institute of Civil Engineers, 8.
Royal Institution, 3. "Digestion," by Professor A. Gamgee.
WEDNESDAY, 31st.—Society of Arts, 8.
THURSDAY, June 1st.—Royal Institution, 3. "The Metals," by Prof. Dewar.
Royal Society Club, 6.30.
Chemical, 8. "Spectroscopic Study of Chlorophyll," Drs. Lapraik and Russell.
FRIDAY, 2nd.—Royal Institution, 8. "The Intellectual Basis of Music," by Mr. H. H. Statham, at 9.
SATURDAY, 3rd.—Royal Institution, 3. "Poetry and its Literary Forms," Professor D. Masson.

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THE CHEMICAL NEWS.

Vol. XLV. No. 1175.

ON THE CAUSE OF THE LIGHT BORDER FREQUENTLY NOTICED IN PHOTOGRAPHS JUST OUTSIDE THE OUTLINE OF A DARK BODY SEEN AGAINST THE SKY;

WITH SOME INTRODUCTORY REMARKS ON

PHOSPHORESCENCE.*

By PROFESSOR G. G. STOKES, Sec. R.S.

AN observation I made the other day with solar phosphori, though not involving anything new in principle, suggested to me an explanation of the above phenomenon which seems to me very likely to be the true one. On inquiring from Captain Abney whether it had already been explained, he wrote: "The usual explanation of the phenomenon you describe is that the silver solution on the part of the plate on which the dark objects fall has nowhere to deposit, and hence the metallic silver is deposited to the nearest part strongly acted upon by light." As this explanation seems to me to involve some difficulties, I venture to offer another.

1. I will first mention the suggestive experiment, which is not wholly uninteresting on its own account, as affording a pretty illustration of what is already known, and furnishing an easy and rapid mode of determining in a rough way the character of the absorption of media for rays of low refrangibility.

The sun's light is reflected horizontally into a darkened room, and passed through a lens,† of considerable aperture for its focal length. A phosphorus is taken, suppose sulphide of calcium giving out a deep blue light,‡ and a position chosen for it which may be varied at pleasure, but which I will suppose to be nearer to the lens than its principal focus, at a place where a section of the pencil passing through the lens by a plane perpendicular to its axis shows the caustic surface well developed. A screen is then placed to intercept the pencil passing through the lens, and the phosphorus is exposed to sunlight or diffuse daylight, so as to be uniformly luminous, and is then placed in position; the screen is then removed for a very short time and then replaced, and the effect on the phosphorus is observed.

Under the circumstances described there is seen a circular disk of blue light, much brighter than the general ground, where the excitation of the phosphorus has been refreshed. This is separated by a dark halo from the general ground, which shines by virtue of the original excitation, not having been touched by the rays which came through the lens.

2. The halo is due to the action of the less refrangible rays, which, as is well known, discharge the phosphorescence. Their first effect, as is also known, is, however, to cause the phosphorus to give out light; and if the exposure were very brief, or else the intensity of the discharging rays were sufficiently reduced, the part where they acted was seen to glow with a greenish light, which faded much more rapidly than the deep blue, so that after a short time it became relatively dark.

3. This change of colour of the phosphorescent light

can hardly fail to have been noticed, but I have not seen mention of it. In this respect the effect of the admission of the discharging rays is quite different from that of warming the phosphorus, which as is known causes the phosphorus to be brighter for a time, and then to cease phosphorescing till it is excited afresh. The difference is one which it seems important to bear in mind in relation to theory. Warming the phosphorus seems to set the molecules more free to execute vibrations of the same character as those produced by the action of the rays of high refrangibility. But the action of the discharging rays changes the character of the molecular vibrations, converting them into others having on the whole a lower refrangibility, and being much less lasting.

4. Accordingly when the phosphorus is acted on simultaneously by light containing rays of various refrangibilities, the tint of the resulting phosphorescence, and its more or less lasting character, depend materially on the proportion between the exciting and discharging rays emanating from the source of light. Thus daylight gives a bluer and more lasting phosphorescence than gaslight or lamplight. I took a tablet which had been exposed to the evening light, and had got rather faint, and, covering half of it with a book, I exposed the other half to gaslight. On carrying it into the dark, the freshly exposed half was seen to be much the brighter, the light being, however, whitish, but after some considerable time the unexposed half was the brighter of the two.

Again, on exposing a tablet, in one part covered with a glass vessel containing a solution of ammonio-sulphate of copper, to the radiation from a gas flame, the covered part was seen to be decidedly bluer than the rest, the phosphorescence of which was whitish. The former part, usually brighter at first than the rest, was sure to be so after a very little time. The reason of this is plain after what precedes.

A solution of chromate of potash is particularly well suited for a ray filter when the object is to discharge the phosphorescence of sulphide of calcium. While it stops the exciting rays it is transparent for nearly the whole of the discharging rays. The phosphorescence is accordingly a good deal more quickly discharged under such a solution than under red glass, which along with the exciting rays absorbs also a much larger proportion than the chromate of the discharging rays.

5. I will mention only one instance of the application of this arrangement to the study of absorption. On placing before excited sulphide of calcium a plate of ebonite given me by Mr. Preece as a specimen of the transparent kind for certain rays of low refrangibility, and then removing the intercepting screen from the lens, the transmission of a radiation through the ebonite was immediately shewn by the production of the greenish light above-mentioned. Of course, after a sufficient time the part acted on became dark.

6. I will mention two more observations as leading on to the explanation of the photographic phenomenon which I have to suggest.

In a dark room, an image of the flame of a paraffin lamp was thrown by a lens on to a phosphorescent tablet. On intercepting the incident rays after no great exposure of the tablet, the place of the image was naturally seen to be luminous, with a bluish light. On forming in a similar manner an image of an aperture in the window shutter, illuminated by the light of an overcast sky reflected horizontally by a looking-glass outside, this image of course was luminous; it was brighter than the other. On now allowing both lights to act simultaneously on the tablet, the image of the flame being arranged to fall in the middle of the larger image of the aperture, and after a suitable exposure cutting off both lights simultaneously, the place of the image of the aperture on which the image of the lamp had fallen was seen to be less luminous than the remainder, which had been excited by daylight alone. The reason is plain. The proportion of rays of lower to rays of higher refrangibility is much greater in lamplight

* A Paper read before the Royal Society, May 25th, 1882.

† The lens actually used was one of crown glass which I happened to have; a lens of flint glass would have been better, as giving more separation of the caustic surfaces for the different colours.

‡ The experiments were actually made, partly with a tablet painted with Balmain's luminous paint, partly with sulphide of calcium and other phosphori in powder.

than in the light of the sky; so that the addition of the lamplight did more harm by the action of the discharging rays which it contained on the phosphorescence produced by the daylight, than it can do good by its own contribution to the phosphorescence.

7. The other observation was as follows:—The same tablet was laid horizontally on a lawn on a bright day towards evening, when the sun was moderately low, and a pole was stuck in the grass in front of it, so as to cast a shadow on the tablet. After a brief exposure the tablet was covered with a dark cloth, and carried into a dark room for examination.

It was found that the place of the shadow was brighter than the general ground, and also a deeper blue. For a short distance on both sides of the shadow the phosphorescence was a little feebler than at a greater distance.

This shows that, though the direct rays of the sun by themselves alone would have strongly excited the phosphorus, yet acting along with the diffused light from all parts of the sky, they did more harm than good. They behaved, in fact, like the rays from the lamp in the experiment of § 6. The slightly inferior luminosity of the parts to some little distance on both sides of that on which the shadow fell, shows that the loss of the diffuse light corresponding to the portion of the sky cut off by the pole was quite sensible when that portion lay very near the sun.

All this falls in very well with what we know of the nature of the direct sunlight and the light from the sky. In passing through the atmosphere, the direct rays of the sun get obstructed by very minute particles of dust, globules of water forming a haze too tenuous to be noticed, &c. The veil is virtually coarser for blue than for red light, so that in the unimpeded light the proportion of the rays of low to those of high refrangibility goes on continually increasing, the effect by the time the rays reach the earth increasing as the sun gets lower, and has accordingly a greater stretch of air to get through. Of the light falling upon the obstructing particles, a portion might be absorbed in the case of particles of very opaque substances, but usually there would be little loss this way, and the greater part would be diffused by reflection and diffraction. This diffused light, in which there is a predominance of the rays of higher refrangibility, would naturally be strongest in directions not very far from that of the direct light; and the loss accordingly of a portion of it where it is strongest, in consequence of interception by the pole in front of the tablet, accounts for the fact that the borders of the place of the shadow were seen to be a little less luminous than the parts at a distance.

8. The observations on phosphorescence just described have now prepared the way for the explanation I have to suggest of the photographic phenomenon.

It is known that, with certain preparations, if a plate be exposed for a very short time to diffuse daylight, and be then exposed to a pure spectrum in a dark room, on subsequently developing the image it is found that while the more refrangible rays have acted positively, that is, in the manner of light in general, a certain portion of the less refrangible have acted in an opposite way, having undone the action of the diffuse daylight to which the plate was exposed in the first instance.

It appears, then, that in photography, as in phosphorescence, there may in certain cases be an antagonistic action between the more and less refrangible rays, so that it stands to reason that the withdrawal of the latter might promote the effect of the former.

Now the objective of a photographic camera is ordinarily chemically corrected: that is to say, the minimum focal length is made to lie, not in the brightest part of the spectrum, as in a telescope, but in the part which has strongest chemical action. What this is depends more or less on the particular substance acted on; but taking the preparations most usually employed, it may be said to lie about the indigo or violet. Such an objective would be much under-corrected for the red, which accordingly would be much out of focus, and the ultra-red still more so.

When such a camera is directed to a uniform bright object, such as a portion of overcast sky, the proportion of the rays of different refrangibilities to one another is just the same as if all the colours were in focus together; but it is otherwise near the edge of a dark object on a light ground. As regards the rays in focus, there is a sharp transition from light to dark; but as regards rays out of focus, the transition from light to dark though rapid is continuous. It is, of course, more nearly abrupt the more nearly the rays are in focus. Just at the outline of the object there would be half illumination as regards the rays out of focus. On receding from the outline on the bright side, the illumination would go on increasing, until on getting to a distance equal to the radius of the circle of diffusion (from being out of focus) of the particular colour under consideration the full intensity would be reached. Suppose, now, that on the sensitive plate the rays of low refrangibility tend to oppose the action of those of high refrangibility, or say act negatively, then just outside the outline the active rays, being sharply in focus, are in full force, but the negative rays have not yet acquired their full intensity. At an equal distance from the outline on the dark side the positive rays are absent, and the negative rays have nothing to oppose, and therefore simply do nothing.

9. I am well aware that this explanation has need of being confronted with experiment. But not being myself used to photographic manipulation, I was unwilling to spend time in attempting to do what could so much better be done by others. I will, therefore, merely indicate briefly what the theory would lead us to expect.

We might expect, therefore, that the formation of the fringe of extra brightness would depend:—

(1.) Very materially upon the chemical preparation employed. Those which most strongly exhibit the negative effect on exposure to a spectrum after a brief exposure to diffuse light might be expected to show it the most strongly.

(2.) Upon the character of the light. If the light of the bright ground be somewhat yellowish, indicating a deficiency in the more refrangible rays, the antagonistic effect would seem likely to be more strongly developed, and, therefore, the phenomenon might be expected to be more pronounced.

(3.) To a certain extent on the correction of the objective of the camera. An objective which was strictly chemically corrected might be expected to show the effect better than one in which the chemical and optical foci were made to coincide, and much better than one which was corrected for the visual rays.

It is needless to say that on any theory the light must not be too bright or the exposure too long; for we cannot have the exhibition (in the positive) of a brighter border to a ground which is white already.

P.S.—Before presenting the above paper to the Royal Society I submitted it to Captain Abney, as one of the highest authorities in scientific photography, asking whether he knew of anything to disprove the suggested explanation. He replied that he thought the explanation a possible one, encouraged me to present the paper, and kindly expressed the intention of submitting the question to the test of experiment.

Photo-chemical Reaction of Iron Peroxalate.—M. Jodin.—The photo-chemical sensitiveness of oxalo-ferric solutions varies considerably with their composition. If we take a solution containing per litre 4 mol. of ferric chloride and 1 mol. of oxalic acid, and compare it with a solution containing 3 mols. of each, the photo-chemical sensitiveness of the former is five or six times greater than that of the second. This decrease of sensitiveness with increasing concentration seems connected with a certain complexity of the photo-chemical and photo-thermic properties of ferric chloride.—*Comptes Rendus*.

ON THE TRANSFORMATION OF PHENOLS
AND ALCOHOLS INTO AMINES.

By V. MERZ.

MERZ and Weith have previously shown (*Berl. Ber.*, xiv, p. 2343) that a mixture of resorcinol with the compound of aniline and calcium chloride, on sufficient heating, furnishes large quantities of meta-oxy-diphenylamine. But according to more recent experiments made in their laboratory by Dr. Calm, the presence of a dehydrating substance is not necessary for starting the reaction: meta-oxy-diphenylamine is, indeed, already formed by simply heating for some time resorcinol and aniline up to 300°; but the yield is moderate.

In similar circumstances hydroquinone is much more easily acted upon by aniline than is resorcinol. In this case, besides para-oxy-diphenylamine,—



also the diamine,—



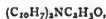
is formed. The former compound is easily soluble in alkaline liquids, also in dilute hot mineral acids; the latter is insoluble in alkaline liquids, and but sparingly so in dilute mineral acids, so that they can be separated without difficulty. Para-oxy-diphenylamine is very sparingly soluble in cold water, moderately so in hot water, not much more in petroleum spirit, but easily in benzene, alcohol, and ether. From the hot solution in petroleum spirit the oxy-compound crystallises in brilliantly shining scales; it fuses at 68.5° to 69°, and distils unchanged. The diamine is not soluble in water; easily so in alcohol, ether, and benzene, but sparingly even in hot petroleum spirit. But first from this solution it crystallises especially well in white brilliant laminae, fusing at 152°. Both amines give colour reactions.

Mr. Buch has found (in the same laboratory) that on heating orcinol with aniline-calcium chloride the compound—

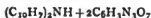


is formed in large quantities. Here also the reaction partly goes beyond the monamine. Oxy-tolyl-phenylamine crystallises from hot petroleum spirit, or from a large quantity of water, in shining scales, fusing at 79°.

A mixture of α -naphthol, β -naphthylamine, and calcium chloride has been found by Mr. Benz to furnish no mixed dinaphthylamine, but essentially only β -dinaphthylamine. But β -dinaphthylamine is formed on heating β -naphthol, α -naphthylamine, and calcium chloride in considerable quantities. It crystallises from a mixture of alcohol and ether, either in flat or in thick prisms of glassy lustre; it fuses at 110° to 111°. Its acetyl derivative,—



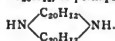
crystallises from alcohol in thick needles, fusing at 124.5° to 125°. The picric acid compound,—



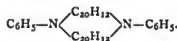
is sparingly soluble; it forms brownish black, shining needles, and fuses at 172° to 173°.

Dr. Walder has examined the behaviour of β -dinaphthol, which is now easily prepared, towards the zinc chloride compounds of ammonia and aniline. The reactions here take place with much more difficulty than with undensified naphthols; the temperature must be raised to 300°.

Ammonia zinc chloride* and β -dinaphthol furnish a well-crystallising substance, $\text{C}_{20}\text{H}_{13}\text{N}$, which formula can be interpreted $\text{HN}=\text{C}_{20}\text{H}_{12}$, or perhaps rather—



It crystallises from a mixture of benzene and petroleum spirit in coniform crystals; from a mixture of ether and alcohol, in colourless, shining needles. It is easily soluble in benzene and ether, sparingly so in alcohol, fuses at 157°, and is carbonised at a higher temperature. By heating it with acetyl chloride on the water-bath only a mono-substitution derivative, $\text{C}_{20}\text{H}_{12}(\text{C}_2\text{H}_5\text{O})\text{N}$, is formed, which crystallises in white needles, and fuses at 144°. The picric acid compound, $\text{C}_{20}\text{H}_{13}\text{N} + 2\text{C}_6\text{H}_3\text{N}_3\text{O}_7$, forms small, shining, black needles; it is sparingly soluble, and fuses at 216° to 217°. The product of the reaction of β -dinaphthol and aniline-zinc chloride crystallises from hot benzene alcohol or ether alcohol in vividly shining needles or prisms, fusing at 144°. Their analysis seems to prove the formula $\text{C}_{26}\text{H}_{17}\text{N}$, that is, $\text{C}_6\text{H}_5\text{—N}=\text{C}_{20}\text{H}_{12}$, or more probably—



This would be a tertiary amide. In fact the substance was not acted upon by acetyl chloride under ordinary circumstances. Its solubility is similar to that of the amine from β -dinaphthol and ammonia-zinc chloride. It furnishes with picric acid a compound crystallising from hot benzene in brownish red needles, $\text{C}_{26}\text{H}_{17}\text{N} + 2\text{C}_6\text{H}_3\text{N}_3\text{O}_7$, fusing at 169°.

It is well known that amyl alcohol and aniline-zinc chloride, on heating, do not produce amyl-aniline, but a primary amine,—



Exactly the same reaction with aniline-zinc chloride takes place with other alcohols of the ethylic series, perhaps even of other series.

Mr. Benz on heating absolute alcohol with aniline-zinc chloride to 260° to 280°, obtained, as principal products, a large quantity of amido-ethyl benzene,—



the boiling point (about 214°), the very slight solubility of the sulphate, and the fusing-point of its acetyl-derivative (94.5° to 95°) proves its identity with the already known para-ethyl-amido-benzene. Also the preparation of ethylamidotoluene,—



from orthotoluidine-zinc chloride and alcohol offers no difficulties. This base is oily, almost colourless, and boils about 230°. Its sulphate, and especially its oxalate, is very slightly soluble in pure cold water. The acetyl derivative crystallises, like that of amido-ethyl-benzene, in very fine, long, white, shining needles and fuses at 105 to 105.5°.

Mr. Louis found that on heating propylic alcohol with aniline-zinc chloride there is formed, as principal product, a considerable quantity of amido-propyl benzene,—



* When zinc chloride alone acts upon β -dinaphthol a dinaphthylene oxide is formed which is very similar to, but not identical with, the derivative of ordinary β -naphthol. The oxidation of β -dinaphthol in alkaline solution by potassium permanganate furnishes no phthalic acid, but a well-crystallising acid, $\text{C}_{18}\text{H}_{11}\text{O}_4$, whose examination is in progress.

Isopropyl alcohol furnishes amido-isopropyl benzene. Both amines are colourless oils: the propyl base distils at 212° to 216° , the isopropyl base at 216° to 217° . They form well-crystallising salts; their sulphates are but slightly soluble in cold water, that of the iso-base even in hot water. The acetyl and the benzoyl derivative of the propyl compound—



crystallise in pretty white scales; the former fuses at 87° , the latter at 115° . The amido-propyl-benzene was, with intermediate preparation of a diazo-compound, transformed into a phenol,—



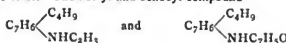
which is an aromatic-smelling oil, boiling regularly between 227° and 228° .

On heating isobutyl alcohol with aniline-zinc chloride, or with aniline and phosphorus pentoxide, there was formed an amido-isobutyl-benzene, which is identical with that prepared by Huder from aniline hydrochlorate and isobutyl alcohol.

Mr. Erhardt on heating isobutyl alcohol with orthotoluidine-zinc-chloride obtained an oily amido-isobutyl-toluene,—



boiling at 234° to 236° . Here, also, the sulphate is but slightly soluble and thus lends itself for preparing the base in the pure state. The acetyl and benzoyl compound—



both crystallise from alcohol in white scales of silvery lustre; the former fused rather slowly at 138° to 141° , the latter sharply at 142° . The base can be transformed by a well-known process into a phenol, viz., isobutyl orthocresol—



and that perfectly smoothly. The new cresol is a colourless oil of very pleasant smell, boiling constantly at 235° .

Further researches will show whether the above-mentioned amines contain the introduced alcoholic radicle always in the para-position towards the amido-group, as is certain for amido-ethyl benzene, or if other positions may also occur. It is remarkable that paratoluidine, as far as can be inferred from its behaviour towards isobutyl alcohol, enters much less easily into reactions with alcohols than its isomer, orthotoluidine, where the para-position is still free.

Depression of the Zero-point in Mercurial Thermometers.—J. M. Crafts.—The author refers to the known fact that a thermometer which has remained for a long time at common temperatures exhibits a depression of its zero-point when heated. M. Pernet has shown that between 0° and 100° the depressions are proportionate to the squares of the temperatures. At higher temperatures M. Mills has found a different law. The values obtained by this observer resemble those found with thermometers which have not undergone a suitable preparation, and differ greatly from the results obtained by the author. For the details we must refer to the original paper.—*Comptes Rendus*, vol. 94, No. 19.

THE PTOMAINES AND THEIR SIGNIFICANCE IN JUDICIAL AND TOXICOLOGICAL CHEMISTRY.*

By Prof. TH. HUSEMANN.

WHEN the formation of ptomaines is particularly frequent in corpses which have been subjected to a slow process of decomposition, it is to be presumed that the same will be not unfrequently observed in the cadavers of persons which have been destroyed by acute arsenical poisoning. To such a probability Selmi had already pointed; but it was only some years later that he succeeded in furnishing the proof that peculiar bases are here in question, which contain arsenic, and which deviate in their properties from the hitherto known arsenies. It will not appear strange that these cadaver bases containing arsenic possess a strongly poisonous action, as is indeed the case with the various artificially prepared arsenies.

Selmi† had already in 1878 reported two cases in which strongly poisonous and crystalline ptomaines were found by him in exhumed bodies containing arsenic. In the first case the subject was that of a corpse exhumed fourteen days after burial, which appeared well preserved, and in which a large amount of arsenic was detected. By the search for alkaloids with ether in the liquid made alkaline with baryta, a small quantity of a substance having an alkaline reaction and a sharp and bitter taste was found. It crystallised readily in needles, gave with acids crystallisable salts, and precipitates with the principal alkaloidal reagents, but not with platinum chloride, with which a precipitate was only obtained in very concentrated solution. With sulphuric acid this ptomaine gave a reddish colouration; with iodic acid, and afterward with sulphuric acid, free iodine was liberated and a violet colouration produced, which completely disappeared by neutralisation with sodium bicarbonate; nitric acid coloured it beautifully yellow, and by saturation with caustic potassa this colour appeared still more perceptible; sulphuric acid containing nitric acid produced only after some time a reddish colouration; iodine in hydriodic acid gave no crystalline product. The amount of material did not suffice for a more complete chemical and physiological examination.

A short time afterwards Selmi succeeded in obtaining larger amounts of a more readily crystallisable ptomaine from a body containing arsenic, which had been exhumed one month after death. For obtaining the same the liquid obtained by extracting with aqueous alcohol was concentrated at from 35° to 45° C. to 70 c.c., then made alkaline with baryta, and shaken with ether. After the separation of the ether by distillation and spontaneous evaporation, there remained 5 c.c. of a turbid and somewhat coloured aqueous liquid, having an alkaline reaction, and a sharp, somewhat bitter taste. After the addition of a little water containing acetic acid, with which the retort used in distilling was washed, filtration, and evaporation to dryness at a moderate temperature, the residue was taken up with water, whereby a little colouring matter remained undissolved, the solution made alkaline with a little baryta, and the extraction with ether repeated. By the treatment of the alkaloid, which was thus obtained nearly colourless, with water containing acetic acid, evaporating to dryness, and again dissolving, a colourless solution was finally obtained, which showed the following behaviour towards alkaloidal reagents:—

Tannic acid, a white permanent precipitate.

Iodine in hydriodic acid, a kermes-brown precipitate, gradually disappearing, and furnishing microscopical colourless and branched, but no yellow or brown, crystals.

Platinic chloride, no precipitate, but in the course of

* Translated from *Archiv. der Pharm.*, xvi. December, 1884, pp. 415-424, by Fred. B. Power.
† *Atti della R. Accad. dei Lincei*, ser. 3, vol. 2, 1878.

time yellow crystals appeared, which were different from those of platinum chloride.

Auric chloride, a yellow precipitate was directly produced, and in a short time reduction to metallic gold.

Mercuric chloride, a white precipitate.

Potassium bichromate, no precipitate.

Picric acid produced directly a yellow precipitate, which in time changed to long crystalline tables of a yellow colour.

The evaporated residue of the solution in question dissolved in cold concentrated sulphuric acid without colouration, although on warming a slight red colour was produced, which did not change to brown. Sulphuric acid and potassium bichromate gave no colour reaction. With Fröhde's reagent the solution remained likewise uncoloured; a light yellow colour, which appeared after standing for an hour, disappeared quickly, as also the insignificant brown colouration on warming. With iodic acid no iodine was liberated, even after the addition of several drops of sulphuric acid; but, on warming, free iodine appeared quickly, and on saturating with sodium bicarbonate the violet colouration disappeared. Sulphuric acid containing nitric acid produced a permanent, beautiful lemon-yellow colouration. Nitric acid produced, likewise, such a colouration, which, on saturating with caustic potassa, changed to orange. On warming, the yellow colour remained, and by the evaporation of the solution over a moderate alcohol flame a material of the same colour was obtained, which, on the approach of a glass rod moistened with ammonia, passed into an intense orange colour.

In order to ascertain whether arsenic was contained in the plomaine, the strongly poisonous property of which Prof. Vella had demonstrated by an experiment on a frog, Selmi sought to destroy the same with nitric acid, but this did not succeed, as an ochre-yellow residue remained, which also resisted the action of *aqua regia*. A better result was obtained by treatment with sulphuric acid and saltpetre. The dry substance dissolved in hydrochloric acid gave neither a yellow colouration nor a precipitate with hydrogen sulphide, even after eighteen hours, which, as several milligrams were employed for oxidation, would demonstrate the absence of arsenic. As the difficulty of destruction of this base showed an analogy to those substances containing phosphoric acid, the residue obtained by the evaporation of the hydrochloric acid solution was dissolved in nitric acid, and the molybdic acid reagent added: but neither a yellow colouration nor precipitation ensued, so that the presence of phosphorus cannot come in question.

While in these plomaines the presence of arsenic could not be definitely proven, Selmi succeeded later in discovering organic bases containing arsenic in the stomach of a hog, which had been preserved in a solution of arsenious acid in a closed vessel in a cool room. On opening the vessel no corrupt odour was perceptible, and also no inclination to the destruction of the tissue. The liquid, which had a slightly alkaline reaction, yielded on distillation in a current of hydrogen a clear alkaline distillate, in which isolated white and fatty flakes were found floating. After careful saturation of the filtrate with hydrochloric acid and evaporation in a bath of salt water, a white non-deliquescent hydrochlorate remained in cross-shaped crystals, which on exposure to the air remained dry, and when moistened with a drop of solution of caustic soda developed a peculiar odour, which resembled to a certain extent that of trimethylamine, although the base could be neither confused with the latter, with other methylamines, nor with propylamine. The hydrochlorate of this volatile base was definitely recognised as containing arsenic, as Selmi found by destroying it, then oxidising with nitric acid, taking up the residue with sulphuric acid, reducing the arsenic acid by means of sulphurous acid to arsenious acid, and finally testing in Marsh's apparatus. This body gave with tannic acid no precipitate; with iodine in hydriodic acid a precipitate of beautiful crystals of a grey colour and the appearance of iodine; with picric

acid a yellow precipitate, which changed to long, yellow, felt-like needles. Auric sulphate gave no precipitate, but a very small amount of a powder consisting of very small and transparent microscopic crystals was deposited. Also potassio-bismuthic iodide and phospho-wolframate of sodium gave at first no precipitate, but afterwards the former deposited a few yellow flakes and the latter a white precipitate. Platinic chloride gave directly a granular canary-yellow precipitate of microscopic octahedrons. Auric chloride gave only in very concentrated solution an insignificant precipitate, which under the microscope consisted of fine, yellow, rhombic tables. Mercuric chloride produced even in highly concentrated solution no turbidity. According to experiments made by Prof. Ciaccio with 24 milligrams of the substance, this base is most intensely poisonous and resembles strychnine in its action.

In order to ascertain whether, besides this volatile base, a fixed alkaloid was still contained in the liquid remaining on distillation and in the solid matter, the latter was comminuted, the residue from the retort poured upon it, acidulated with tartaric acid and four times its volume of alcohol added. After digesting till the following day, the alcoholic liquid was separated from the solid matter, the latter again extracted with alcohol, the alcoholic liquids filtered, combined and distilled *in vacuo* until the alcohol was entirely expelled. The brown residue was made alkaline with barium hydrate, and shaken three times with ether. By the distillation of the brown liquid obtained by the first treatment with ether, which possessed an alkaline reaction, a distillate having a peculiar odour was obtained, which differed from that of the previously described volatile base. After spontaneous evaporation there remained a residue, which after some days acquired an unendurably disagreeable odour, although the base had been converted into hydrochlorate, which afterwards deliquesced. The small quantity prevented an exact examination.

The residue from the distillation of the ether was brown, glutinous, alkaline, and nearly insoluble in water. After treatment with very dilute hydrochloric acid with the aid of heat, and filtering off the separated fatty matter, as also after the purification of the yellowish coloured filtrate by treatment with baryta and agitation with ether, a distillation residue was obtained, having an alkaline reaction and a somewhat cadaverous odour which, at first slightly coloured, by exposure to the air became brown and at the same time insoluble in water. By the addition of a few drops of dilute hydrochloric acid, until the reaction was feebly acid, and moderately warming, a yellowish solution of somewhat disagreeable odour and bitter taste was obtained, which, when brought upon the tongue, produced a prurient sensation and afterwards loss of sensibility. This gave with tannin a slowly separating, yellowish precipitate; with hydriodic acid containing iodine a yellowish red precipitate and brown drops; with platinic chloride a yellowish powder, that even after several hours did not become crystalline; auric chloride gave a yellowish precipitate, and in a short time reduction ensued; mercuric chloride and potassio-mercuric iodide gave yellowish white precipitates; potassio-bismuthic iodide an orange-yellow precipitate, changing to red; picric acid a non-crystalline, and potassium bichromate a reddish yellow, precipitate.

This alkaloid also contained arsenic, and, according to the experiments made by Prof. Ciaccio on frogs, possessed a poisonous action, which, however, was different from the strychnine-like action of the volatile arsenic, and was connected with the ordinary action of the poisonous plomaines. Torpor, paralysis, and systolic inactivity of the heart were the most prominent phenomena.

The communicated research of Selmi throws light upon one of the darkest portions of the history of toxicology to the time of Toffia and other professional poison mixers, who understood rendering the activity of arsenious acid to a certain extent more potent. With the "*Aqua toffiana*," the so-called "*Acquetta di Perugia*," played at the same

time in Italy a not insignificant part. According to the tradition, this secret compound of the poison mixers of the 17th and 18th centuries was prepared by killing a hog, disjointing the same, strewing the pieces with white arsenic, which was afterwards rubbed in, and collecting the arsenical liquid which dropped therefrom. A liquid obtained in this way was said to have possessed a much more poisonous action than a simple solution of arsenious anhydride. There can be no doubt that by the longer preservation of pork, or any other kind of meat, peculiar arsines were formed, and impart to the arsenical brine poisonous properties which surpass those of the arsenious acid, at least when applied in the solid form. It must also be considered that by this process compounds of arsenious acid with inorganic alkalies are also undoubtedly formed, which are more readily absorbed than the arsenious acid, and that the respective procedure had for its purpose to bring the largest possible amount of arsenious acid into solution. The same object was presumably in view by the preparation of the Aqua toffana with the addition of a plant juice, for which, as is known, that of *Linaria Cymbalaria* was added. Selmi and Vella presume that through the Acquetta di Perugia the concealment of the action of the arsenic on the one hand, and of the tetanic poisons on the other, was accomplished. This supposition, which is based on an observation of Vella in a case of complex poisoning with arsenic and strychnine, does not agree perfectly with the experiments on warm-blooded animals, by which, through the simultaneous application of arsenite of potassium and strychnine, the tetanic spasms were not prevented, provided that the strychnine was given in a toxic dose.

From still another point of view the ptomaines containing arsenic appear to be of significance in toxicology, from the fact that they help to explain an affection, that of chronic arsenical poisoning, as produced by arsenical wall-papers. As Selmi has shown that a volatile arsine is formed by the contact of arsenious acid and albuminous matters, which possesses a strongly toxic action and differing somewhat from that of arsenious acid, the author thinks it may be presumed that a similar product can be formed from the glue which is employed for affixing the arsenical wall-paper of a room, whereby perhaps the moisture of the air plays a part in the formation of the arsine.—*American Journal of Pharmacy*, April, 1882.

ON THE
CRYSTALLINE FORMS OF ZIRCONIA
AND ON THE
CONCLUSIONS TO BE DRAWN FROM THEM
FOR THE QUALITATIVE DETERMINATION
OF ZIRCONIUM.

By A. M. LEVY and L. BOURGEOIS.

ON attacking zircon at a high temperature with sodium carbonate, we obtain, after cooling the fused mass and lixiviating with hot water, a crystalline powder, very hardly attacked by acids and composed of zirconia, sensibly pure. A microscopic examination of the mass shows that the crystals exist there previously to lixiviation. Zirconia therefore crystallises in an excess of melted sodium carbonate. These crystals appear in two forms according to the temperature and the quantity of sodium carbonate employed. On operating with a weight of the flux ten times that of the zircon, and raising the mixture to white redness, if the quantity of zircon does not exceed 0.01 gram, there are formed especially rectangular crystalline aggregations. Their most perfect type consists in the association of six crystals, grouped according to the quaternary axes of a cube. Each element is a small transparent prism with a terminal point of about 72°. These delicate productions may also be obtained from

pure zirconia. Analysis shows no trace of silica, and only 1 to 2 per cent of soda, which appears to be due to impurities. Platinum is always present up to 10 per cent, and is due to the corrosion of the crucible. The compound which it forms is incorporated as an isomorph with the zircon and colours the crystals yellow. When this colouration is strong the phenomena of polarisation become very sensible.

On operating at bright redness and with a weight of sodium carbonate twice that of the zircon, the zirconia crystallises after a few minutes in the flux. After lixiviation in hot water we obtain transparent hexagonal lamellae. The elementary forms of these hexagons are totally different from the former kind. These phenomena appear similar to those presented by tridymite. The two forms of zirconia obtained appear incompatible with each other. The zircon of Espailly, treated with twice its weight of sodium carbonate at a bright red heat for five minutes, yields, after cooling and lixiviation, a weight of hexagonal lamellae of zirconia representing approximately the total contained in the mineral. 0.005 gram of zirconia suffices to yield one or other of the crystalline products, or a mixture of the two. We have here a micro-chemical reaction of remarkable delicacy and precision, enabling the presence of zirconia to be easily detected. Yttrium, niobium, tungsten, titanium, and tantalum yield nothing similar.—*Comptes Rendus*.

PROCESS FOR THE SEPARATION OF SMALL
QUANTITIES OF NICKEL IN PRESENCE
OF COBALT.

By Dr. A. JORISSEN.

THE action of reducing agents upon nickel hydroxide is well known to be much more energetic than upon cobalt hydroxide, and upon this circumstance there have been founded several methods for the separation and determination of nickel and cobalt. This difference in permanence is especially shown with potassium cyanide, which can be advantageously used for the separation of small quantities of nickel in presence of cobalt. Whilst in fact even a few drops solution of potassium cyanide suffice to reduce and dissolve in the cold a considerable quantity of nickel hydroxide, a very small quantity of cobalt hydroxide is scarcely affected by a large excess of the same reagent. This difference in the behaviour of the two oxides can be advantageously used for the detection and separation of nickel in presence of much cobalt. The two hydroxides are precipitated by the successive application of soda-lye, and of a quantity of bromine sufficient to convert all the nickel and cobalt into oxide. One or two c.c. of solution of potassium cyanide are then added, without previous filtration, and the mixture is well shaken in the cold. It is then filtered, and the filtrate, after addition of *aqua regia*, is evaporated to dryness. On re-dissolving the residue in water, there is obtained a solution of nickelous chloride, which shows the characteristic reactions of nickel very distinctly. The successive application of ammonia and ammonium sulphide is particularly recommended, which gives a dark brown liquid. Or the solution may be treated first with soda-lye and then with bromine. When the black precipitate has thus been formed, two or three drops of potassium cyanide are added. The precipitate disappears very quickly in the cold and a clear solution remains. It must be noted that if a solution of very much nickel and little cobalt is treated in the manner above described, the latter enters into solution.

If two solutions of equal quantities of cobalt are submitted to the above-described process, the one containing in addition a ten-fold proportion of nickel, and if in each case there is added an equal number of c.c. of solution of potassium cyanide, it will be observed that the solution

containing nickel and cobalt is almost entirely decolourised, whilst the other still contains black flocks in suspension. If a small quantity of potassium cyanide is used, it is always possible to separate a quantity of nickel sufficient for recognition.—*Zeitschrift für Analytische Chemie.*

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, April 4, 1882.

R. ANGUS SMITH, Ph.D., F.R.S., &c., in the Chair.

"On the Occurrence of Oxide of Manganese (Wad) in the Yoredale Rocks of East Cheshire," by ARTHUR SMITH WOODWARD, Student of Owens College. Communicated by Dr. CHARLES A. BURGHARDT.

I. Introduction.

One of the most noticeable geological features of the eastern part of Cheshire is the enormous fracture forming the boundary between the carboniferous and new red sandstone formations, and known as the Red Rock Fault. This fault has a direction N.E. and S.W., and, according to the *Memoirs of the Geological Survey*, extends from a little to the N. of Stoneport to Talk of the Hill, in Staffordshire, a distance of about 30 miles. In the more northern part of its course superficial evidence of its existence is either exceedingly scanty or entirely wanting, owing to the thickness of the glacial drift deposits which characterise the district through which it passes; but as it approaches Macclesfield there are slight indications at the surface of its presence, and as it continues south of this town the superficial evidence gradually becomes greater and more definite. Here there are considerable eminences on the western side of it, consisting of triassic strata not obscured by glacial drift; and hence the fault itself becomes visible at the surface.

Between Poynton and a locality about 3 miles south of Macclesfield it is bounded on its eastern side by the carboniferous formations in succession,—the two lower divisions of the coal-measures being most northern, next five divisions of the millstone grits, and below these, more to the south, the Yoredale Rocks; and it is in the latter rocks that the greatest amount of disturbance has arisen from it, in consequence of the fact that they are constituted not of thick, compact masses of sandstone, but of comparatively thin beds alternating with bands of shale. In this locality, in and around Ratcliffe Wood, there is a large number of sections, both natural and artificial, extending for several hundred yards to the eastern side of the fault, and after examining them, and taking note of the dip in each case, it is easily seen that the greatest confusion exists among the strata: small faults are very numerous, and often prove themselves to be great obstacles to the quarrying operations there carried on; and contortions of the beds, varying from only 2 or 3 feet to several yards in extent, abound in all directions. It is in the fissures produced by the disturbance of the beds in this locality that the mineral which I intend to describe in this paper is found.

II. Description of Section.

The quarrying at Ratcliffe Wood is carried on chiefly in tunnels, formed by the excavation of the beds of rock which are best adapted for the purposes to which the stone is applied, namely, repairing and making roads. Some months ago the quarrymen met with a fault which cut off the bed of rock that they were following, and in attempting to find again this lost stratum on the other side of the hill they opened a section nearer to the Red Rock Fault; and

it was here that I first noticed the oxide of manganese, early in December last.

This is the nearest section to the fault now exposed in that locality,—with the exception of comparatively unimportant exposures in the brooks running through the wood,—and is probably not more than 30 or 40 yards from it. As this is a very interesting section, apart from its mineral characteristics, since it shows the effect of the force exerted during the production of the great fault, a somewhat brief description of it may, perhaps, be not out of place at this point.

The principal opening is about 30 feet in length and 20 feet in height, but from the other small sections around it many more details of the stratification can be obtained. The direction of all these sections is nearly at right angles to the fault, namely, E. and W.

The lowest bed exposed consists of variegated soft shale, in small flakes (dip 50°—10° E. of N.); above this is a stratum of sandstone, 5 feet in thickness, containing abundance of MnO₂ in the many fissures which traverse it, and it is a noticeable fact that in the lower portion of the section there is a larger quantity of the mineral than in the upper portion; next is a bed of variegated soft shale, 7 feet in thickness, in flakes, and similar in nature to the bed underlying the sandstone previously mentioned; the remainder of the section consists of alternating bands of shale and sandstone, much broken and contorted, and 14 feet thick, which gradually become more and more bent until they reach a position nearly 5 feet above the underlying bed of shale, when a stratum of sandstone, 8 inches thick, undergoes three decided bends,—in one case a complete break. This sandstone, like all the other beds in the section, has been shattered into small angular fragments, and into the cracks thus formed mineral matter has been introduced by the percolation of water. Many of the smaller fragments have again been cemented together by oxide of iron, as the cracks surrounding them had not separated the adjoining portions of rock far asunder, while the walls of the larger fissures are only coated with oxide of iron and argillaceous matter, or, in the upper part of the section, with oxide of manganese, and are not firmly united together.

Above this contorted bed of sandstone the alternating layers of rock are similarly disturbed for a thickness of about 7 feet, when the arrangement of the beds becomes very obscure, and a little above this the series assumes a nearly vertical dip.

The general appearance of the section shows that the contortions of the series have been produced by a slip, most probably at the time when the Red Rock Fault was formed. This is evident not only from the disturbed beds lying between two series, which have been very little bent, but also from the peculiar appearance of the layer of shale beneath, and the confused mass of broken sandstone above. In the underlying shale there are two or three very thin seams of carbonaceous matter, which are rendered rather conspicuous by their dark colour: these are curiously contorted, having been completely twisted in no less than four places, the interior of the folds being occupied by confused masses of variously coloured crushed shale.

III. Occurrence and Properties of the MnO₂.

The most typical specimens of oxide of manganese (wad) are to be obtained from the fissures in the lower bed of sandstone in the section just described. Here it occurs in considerable quantity, and is in a very accessible place. The walls of the cavities produced by the fissuring of the rock are covered with a layer of the mineral, never more than $\frac{1}{2}$ inch in thickness, which is not at all smooth on the exterior, but has the appearance of soot adhering to the side of a chimney: this form is caused by a pellet-like structure assumed by the substance. The layer appears to cover all the walls of the cavities equally, not becoming perceptibly thicker on the lower sides, and not altering in appearance in different parts.

But the most peculiar and characteristic feature of the

wad in this sandstone is its occurrence in miniature columns, joining the two opposite walls of the cavities, and in long slender threads, stretching in all directions over the rough surface of the mineral incrustation. So far as I have been able to ascertain, none of these columns or threads are perfectly solid, but are all pierced longitudinally by a canal, which is often situated not quite in the centre; in some cases this is so large that the surrounding oxide of manganese becomes very thin, and a delicate tube is formed, while in many specimens the calibre is so small that the perforation can only be seen on close examination. The columns and threads are not all straight, but many are bent in various directions, and not unfrequently branched, the axial canals in all cases being preserved throughout the bifurcations.

These interesting structures in external appearance are rough and dull, but cross-sections exhibit a very distinct resinous lustre. The size of the columns is not great, their diameter never exceeding $\frac{1}{16}$ of an inch, and their length being seldom much more than one inch; the tubular threads are sometimes four or five inches long, but their diameter is very much less than that of the columns, few of them having a section greater than $\frac{1}{16}$ inch across.

To account for the formation of these columns and threads appears, at first sight, a somewhat difficult matter, but after carefully taking into consideration the position of the mineral and the nature of its surroundings, an explanation is afforded which has been definitely proved to be correct by Mr. Dale, of Macclesfield.

The position which the greater part of the oxide of manganese occupies is about 14 feet from the surface, a depth to which the roots and rootlets of the surrounding wood are able to penetrate by means of the numerous cracks in the strata. Rootlets are to be seen in the fissures in many parts of the section, and in those which are lined with oxide of manganese they are especially abundant. They stretch across the cavities, and traverse the surface of the black mineral in all directions; and after closely searching for some time, it is possible to find specimens to illustrate all stages of the conversion of these organic bodies into columns and threads of oxide of manganese.

Many of the rootlets, probably in their first stages of decomposition, have assumed a reddish or unnatural brownish colour; others, in a later stage, exhibit minute patches of the black oxide studding their surface, appearing as if affected by a black mildew; others are almost entirely covered with the incrusting mineral; while, in the final stage, the whole of the organic matter has disappeared. In short, the rootlets are completely pseudomorphosed into hydrated dioxide of manganese by the action of the decomposing plant tissue upon a solution of some manganese salt.

These facts are interesting as showing that the deposition of oxide of manganese is still taking place, or, at least, did take place until the section was opened. There is no perceptible percolating water, even in the moistest part, but the mineral is at all times moist.

As to the oxide of manganese pseudomorphs, at very few cases of the alteration of organic matter into mineral have been recorded. This oxide is described in Phillips's "Mineralogy,"* in the list to occur as petrifications, but is referred to as "Nachtrag zu den Pseudomorphosen." It has been described as a fossil consisting of manganese, which he stated, in 1842, to be on record of this mineral occurring in gain, in 1851;† he mentioned a fragment from Gonzen, near Sargans (Switzerland), fossilised in the same manner. However, it can be regarded as quite a new phenomenon of the rootlets, since it was

not the truly organic matter that was mineralised, but the surrounding chiefly inorganic shell.

The mineral itself, as found in the bed of rock in the section at Ratcliffe Wood as already described, is of a bluish-black colour when freshly obtained, but assumes a browner tint on exposure: its hardness is less than 2. It is easily crushed into powder between the fingers, and has a characteristic crispness. When heated in a closed tube water is evolved, and under the blowpipe it is infusible. Its streak is of a dark yellowish-brown colour.

A quantitative analysis of the mineral gave the following as its percentage composition:—

| | |
|--------------------------------|----------|
| MnO ₂ | = 33.634 |
| Fe ₂ O ₃ | = 9.375 |
| Al ₂ O ₃ | = 22.913 |
| SiO ₂ | = 16.815 |
| Water | = 17.237 |

99.774

This analysis probably does not show the exact composition of the pure mineral, since it is almost impossible to obtain a sufficient quantity entirely free from the surrounding argillaceous matter.

IV. Distribution of MnO₂ in Ratcliffe Wood.

So far as I am yet aware, there is only one other spot in Ratcliffe Wood where oxide of manganese is to be seen occurring in the same form as the mineral in the section previously described. This is a few hundred yards to the east of the latter, and the deposit exhibits not only the same peculiarities but others which render it even more interesting. Here, as in the previously mentioned case, the mineral occurs both as an incrustation and pseudomorphic after rootlets; but it is also in many parts covered with a thin layer of a white, translucent, crystalline mineral—a highly hydrated phosphate of alumina with a proportion of silicate—which, besides, mineralises rootlets in an analogous manner to the oxide of manganese.

In this same section, too, there is exposed a lenticular mass, 4 ft. 6 in. long and 3 in. in greatest thickness, which is black, earthy, and moist, and evolves chlorine on treatment with hydrochloric acid. It is situated in the midst of shales, and most of the small fissures for some distance beneath it are filled with black oxide of manganese.

The oxide of manganese occurs in many other fissures in and around Ratcliffe Wood, but nowhere so abundantly as in the sections referred to in this paper. The most widely spread form is a thin black film, not sufficiently thick to exhibit to the unassisted eye any pellet-like structure, as is the case with the mineral described above. Such a film is to be seen in some of the fissures in almost every section in the wood, and the fact that the oxide does not occur in larger quantities cannot be owing to the circumstance that there are no cracks exposed so large as those in which it is found in pellets, miniature columns, and threads, but in consequence of its scarcity in the stratum from whence it was derived; for in one quarry there are two faults which produce cavities and fissures of a much larger size, and yet these are well filled with brown iron ore with a comparatively small amount of MnO₂.

In the Triassic strata, on the E. side of the Red Rock Fault, this mineral occurs not only as an infiltration-product, but also as a part of the cementing material of certain thin beds of the sandstone.

V. References to Descriptions of Deposits of Hydrated MnO₂.

On referring to Bischoff's "Chemical Geology" * an enumeration of instances recorded before 1854 of the occurrence of deposits of hydrated oxide of manganese is to be found. Here no less than six cases are mentioned.

During the repair in 1840 of a water channel hewn in

* and Miller, 1852.
† Mineralogist, &c.

* Vol. 1, pp. 160, 161, Edit. 1854.
† Journal für prakt. Chem., vol. 21.

the rock in the neighbourhood of Nürnberg, an immense mass of hydrated oxide of manganese was discovered. A spring near the Cape of Good Hope, whose waters have a temperature of 110° F., is said to deposit in the discharge channel a very thick incrustation of the same mineral, extending to some distance from the spring.* A mineral spring at Carlsbad, depositing a mass resembling manganese, has been described by Kersten. Bracconet examined and described in 1821 a precipitate of oxide of manganese found in the outlets of the springs of Luxeuil. A deposit of the same mineral from the water in a mine at Freiberg has been analysed by Kersten and described in the "Archives für Mineralogie, &c." (vol. 16), and in this journal, also, Nögerrath has given an account of the nature and occurrence of the manganese ores in the Hundsrück, and in Soonwald, on the left bank of the Rhine.

VI. Associated Minerals.

The most important minerals associated with the oxide of manganese in the strata of Ratcliffe Wood, besides the phosphate of alumina already mentioned, are brown iron ore, calc spar, pearl spar, iron pyrites, and zinc blende. The brown iron ore occurs in thin incrustations, in fibrous stalactitic masses, and in hollow spheres which have, especially on the inner side, a very peculiar lustre. The calcite occurs in a crystalline state in small fissures in almost every section, and is found crystallised occasionally in the form — IR. and the combinations — 4 R. 16 R. The pearl spar occurs in many fissures beautifully crystallised in the form — IR; it is tinged with oxide of iron, and the crystal faces are bent in the characteristic manner. Iron pyrites occurs abundantly, often perfectly crystallised; and zinc blende is found in small masses scattered among the crystals of calcite and pearl spar.

VII. Conclusion.

Oxide of manganese occurs in many places in the other Yoredale strata of the district, but nearly always in very small quantities. It also occurs widely spread throughout the overlying Millstone Grits; in these strata it forms dendritic markings radiating from the fissures in the rock, and constitutes a portion of the cementing material in many of the concretions.

In the sandstones of the coal measures, also, oxide of manganese forms part of the cementing material in many of the concretionary structures.

In fact, careful observations would probably show that oxide of manganese is quite as widely distributed as oxide of iron, the only difference being that the former mineral generally occurs in defined patches and in comparatively small quantities. The distributing causes seem to have acted as universally with the one mineral as with the other, but in the case of the manganese only small amounts were concerned, while in the case of the iron there was an almost unlimited supply.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 19, May 8, 1882.

Effects produced in a Vacuum by the Current of Gramme Machines.—MM. Jamin and G. Manuvrier.—The effects are those of batteries with an intensification due to the enormous tension, and those of the coil with the intensification which results from a greater quan-

tity of electricity. When the vacuum reached about 12 m.m. the light began to spring out not in the form of a luminous arc confined between the points, but from all parts of the carbons with the ordinary aspect of the effluve in a Geissler's tube; each of them showed at once the appearances which characterise the two poles with the coil. The carbons are heated to whiteness in their entire length, and become volatilised. The receiver is filled with a blue gas, which gradually deepens almost to the colour of indigo. The vapours then condense on the sides of the receiver, rendering them opaque, and terminating the experiment. The deposit collected resembles very finely-divided carbon, and dissolves in nitric acid with effervescence and incandescence. The nature of this carbonaceous matter is under examination.

General Considerations on Apparatus for Preventing Conflagrations or Pyroscopes.—A. Leduc.—The author, after criticising several devices, suggests the following: He interposes in a single circuit a cylinder of a material at once insulating and not brittle. This cylinder is filled with a liquid not easily liable to electro-lysis, and possessing a good conductive power which increases with the temperature. At each extremity of the cylinder there is a compact plug of tow, through which penetrates a platinum rheophore connected with one of the wires of the circuit. The author recommends alcohol for the liquid in question.

Report upon M. Béchamp's Memoir on the Albumenoids.—This report does not admit of abstraction.

Polarisation of Electrodes and the Conductivity of Liquids.—E. Bouty.—The conductivity of the liquid remains constant, in spite of the variety of electrolytic reactions of which the electrodes may become the seat. This conductivity is always greater than that possessed individually by the solution of any one of the elements of the mixture at the degree of dilution existing in the liquid. Consequently the molecules of each of the mixed salts take part in the transportation of the electricity, even when only one of the metals is deposited at the negative electrode. The polarisation of the positive electrode may generally be neglected. The polarisation of the negative electrode, very slight for currents of mean density, increases rapidly in either direction, and tends, for each mixture, to a fixed limit.

Magnetic Variations of Magnetised Rods during Storms.—G. de Lalagade.—Lightning, even at a distance, has a real action upon the magnetism of magnetic rods, though the influence under ordinary circumstances is neither strong nor rapid enough to be indicated by the needle of the compass.

The Composition and the Volume Equivalent of Pernitric Acid.—P. Hautefeuille and J. Chappuis.—The researches of the authors lead them to assign to this compound the formula $\text{NO}_6 = 4$ volumes.

Action of Potassa upon Lead Oxide.—A. Ditté.—Anhydrous lead oxide presents two distinct crystalline forms. In one it is of a rose-red, crystallising in cubes, or in solids derived from that form. In the other it appears in elongated rhomboidal laminae or needles formed by the grouping of such laminae. Its colour may be a greenish yellow bordering upon white, pure yellow, or greenish yellow of different shades, and deep green almost black. Its density varies from 9.1699 to 9.8835. At a slight rise of temperature all these crystals become red, whilst the red crystals require to be strongly heated before losing permanently their colour.

Chromium Phosphate and its Utilisation in Chemical Analysis and in Industry.—A. Carnot.—Chromium is always determined either as green oxide or as lead or barium chromate. It may also be exactly determined as phosphate, and this method is often convenient. On boiling a solution of a salt of chromium slightly acidified, to which has been added an alkaline phosphate and sodium acetate, the whole of the chromium is precipi-

* L'Institut, 1844.
† Ann. de Chim. et de Phys., 1822.

tated as phosphate. This method succeeds both with the green and the violet salts, chlorides and sulphates, and with the acetates, but not with the oxalates. It is also suitable for alkaline chromates, but in this case the action of the phosphoric acid must be combined with that of sodium thiosulphate (hyposulphite), which acts as a reducing agent. The solution of chromate, to which is added a sufficient quantity of phosphoric acid or of a phosphate, then of acetate, and lastly of hyposulphite, and which has been slightly acidified, is boiled for about an hour; it deposits all the chromium as phosphate, with a little sulphur derived from the hyposulphite. The phosphate precipitated is a green hydrate. It may be washed with boiling water, or, preferably, with hot solutions first of ammonium acetate followed by ammonium nitrate. On calcination it turns grey, and contains chromic oxide in the proportion of 51.86 per cent. In former researches on the determination of aluminium (*Comptes Rendus*, July 18, 1881), the author has shown that alumina can be exactly separated from chrome by converting the latter into an alkaline chromate, acidifying the solution slightly with acetic acid, and adding an excess of sodium phosphate. The mixture is boiled and filtered to separate the aluminium phosphate. When this is done, it is easy to determine the chromium by pouring into the liquid hyposulphite, and, if needful, a further quantity of alkaline phosphate, and boiling. The precipitate of chromium phosphate is then washed, ignited, and weighed. The same reaction is capable of industrial application. It yields an insoluble green colouring-matter, which retains, when dry, a very fine shade, and may be used in painting in place of the dangerous compounds of arsenic and copper. This colour, which is perfectly inoffensive, may also be used in dyeing, as the insoluble green phosphate may be produced in the fibre.

New Carbo-silicated Compounds.—A. Colson.—By heating to bright redness silicon along with lamp-black strongly compressed, the author has obtained compounds answering to the formulae SiC_2 and SiC_3O_2 .

Homologous and Isomeric Rosanilines.—MM. Rosensiehl and Gerber.—The authors consider that there exists a series of six rosanilines. The differences between any two consecutive terms of this series are slight. In a general manner, as the molecule becomes more complicated, the hydrochlorate becomes more soluble in water, crystallises less readily, and dyes wool a violet-red, which approaches more and more to a violet. The base becomes more soluble, the boiling-point of the carbon rises, and substitutions are effected less readily. The action of aniline, which in the first terms produces valuable blue colours, becomes less marked, the quantity of ammonia evolved decreases, and the colouring-matters obtained dye violet-blues.

Composition of Ash emitted by Vesuvius, Feb. 25, 1882.—L. Ricciardi.—The sample is black, rich in small crystals of leucite, and fragments of augite and magnetite. It is in great part magnetic, and when moistened reddens litmus.

Antiseptic Properties of Salicylic Acid.—E. Robinet and H. Pellet.—The authors pronounce salicylic acid a very efficacious antiseptic.

Les Mondes, Revue Hebdomadaire des Sciences.

No. 1, May 6, 1882.

New Electric Lamp.—M. Solignac.—This paper cannot be intelligibly reproduced without the accompanying illustrations.

Relation between the Electromotive Force of the Battery and the Calories of Decomposition of Water.—Dr. D. Tommasi.—The author points out a remarkable difficulty. On the one hand, it is known that in order to decompose a molecule of water into its elements 69 calories are required, and that consequently any

action which does not liberate this quantity of heat is incapable of decomposing water. On the other hand, water may be decomposed by means of excessively feeble currents. Either, therefore, the thermic data are false, or the true cause of the polarisation of the electrodes is not yet known. The former supposition being inadmissible, there must be in the phenomena of polarisation something which has escaped observation. With a De la Rive condenser, a Daniell element incapable of decomposing water decomposes it so as to give off 18 to 20 c.c. of gas per minute. The condenser does not in any manner change the nature of the chemical reaction of the Daniell element, nor consequently its electromotive force. The supplementary calories are produced by the formation of zinc sulphate, which in case of the condenser is doubled.

Annales de la Société des Sciences Industrielles de Lyon. No. 4, 1881.

Inconveniences arising from Certain Industrial Residues as regards Public Health.—M. Vanderpol.—The author points out the injurious action of sulphates, especially gypsum, in contact with organic matter and the carbonic acid of the atmosphere.

Moniteur Scientifique, Queneville. May, 1882.

Foreign Patents.—A list of chemical patents, chiefly German.

The Methods of Quinquaud for the Determination of Urea.—C. Arnold.—The result of the author's researches is that Quinquaud's method, as well as other processes for the determination of urea by means of sodium hypobromite, is entirely unfit for analyses requiring scientific exactness.

Metallurgy of Copper by the Moist Way.—Dr. Sterry Hunt.—From the *CHEMICAL NEWS*.

Determination of Small Quantities of Arsenic in Sulphur.—H. Schaeppi.—Already noticed.

Carbonic Oxide: its Poisonous Action and its Presence in Houses.—M. Gruber.—The author considers that there is a grade of dilution below which this gas ceases to be dangerous. Foder's test—the reduction of palladium chloride—renders it possible to detect a proportion of carbonic oxide in the air four times smaller than what is sufficient to exert a poisonous action. M. Gruber has not succeeded in detecting this gas in the air of rooms heated with iron stoves.

Note on the Determination of Nitric and Nitrous Acids as Ammonia.—A. Guyard (Hugo Tamm).—Already inserted.

MEETINGS FOR THE WEEK.

- MONDAY, June 5th.—Society of Chemical Industry, 8 "On Turpentine—its Nature and Acclimation," by Professor Armstrong. "On Testing of Chimney Gases," by W. J. Lovett. "Estimation of HCl Free and Combined in Chimney Gases," by G. E. Davis.
- TUESDAY, 6th.—Royal Institution, 5. General Monthly Meeting. "Digestion," by Professor A. Gamgee.
- WEDNESDAY, 7th.—Geological, 8. "Obituary," 8.
- THURSDAY, 8th.—Royal Institution, 3. "The Metals," by Professor Dewar.
- FRIDAY 9th.—Royal Institution, 8. "Excitability of Plants," by Prof. Burdon Sanderson, at 9. "Quekett Microscopical Club, 8. Astronomical, 8.
- SATURDAY, 10th.—Royal Institution, 3. "Poetry and its Literary Forms," Professor D. Masson. "Physical," 3. "Experiments on Vibration," D. F. Stanley. "On a Wind Integrator," by Walter Bailey.

THE CHEMICAL NEWS.

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METHOD FOR ACCURATE AND RAPID ANALYSES OF AIR.*

By EDWARD W. MORLEY, M.D., Ph.D.,
Hurlburt Professor of Chemistry in Western Reserve College.

I HAVE made a series of daily analyses in duplicate of air collected at this place for six months beginning with January 1, 1880, and one for six months and twenty days, beginning October 1, 1880. The samples of air were collected in glass with well-fitting glass stoppers. A few drops of solution of potassium hydrate being put into the bottle, this was set in the open air, and the air in the bottle displaced by sufficient aspiration, the observer keeping at a little distance to the leeward side. The stopper was then put in place and wet with the potassium hydrate by inverting the bottle and turning the stopper. Experiment showed that it was possible to keep samples for many days in this way with the certainty that they remained unchanged.

A mercury pump was used to withdraw the sample from the bottle. A rubber stopper was used to make the needed connection with the pump. Experiment showed that this rubber in contact with the alkaline solution does not absorb more than a hundredth per cent of oxygen from the air in the bottle in twenty times the period during which it was in contact with the air used in the analysis. The pump discharged the air into a jar standing over mercury in the laboratory trough of the apparatus for analysis.

This jar being lowered, together with the cistern, over the re-curved capillary end of the eudiometer tube, a certain quantity of air was taken into this tube. This quantity was measured approximately by using a journeyman pressure tube having a small bore. The quantity used was almost always the same, and occupied from 470 to 475 millimetres in length of the eudiometer tube, when the pressure on it was that of a column of mercury of this same length.

This quantity was then measured accurately with the standard pressure tube. This had a Jolly point in the vacuum at the level of the zero of the graduation on the eudiometer tube, which zero was at the top of the tube. The level of the mercury in the standard pressure tube being never permitted to vary more than a fraction of a millimetre, its vacuum was found to remain constant and unimpaired. When the mercury in it had been put in connection with the mercury in the eudiometer, and its upper level had been brought to the Jolly point by the use of a fine adjustment, the level of the mercury in the eudiometer was read with a microscope magnifying fifty diameters, and provided with an eye-piece micrometer. By this arrangement, when everything was prepared, it was possible to verify the contact at the Jolly point, to read the thermometer to the hundredth of a degree, and to read the level of the mercury in the eudiometer, in less than ten seconds. Uncertainty as to the actual temperature at the instant of final reading was in this way mostly avoided. This reading microscope is carried on a vertical cylinder which is solidly attached to the firm iron tripod which supports the whole apparatus. On this cylinder the mounting of the microscope can be clamped at the required height. The microscope is then made to give distinct vision of the graduation on the surface of the eudiometer. This graduation consists of lines not more

than the eight-thousandth of an inch wide, cut with a diamond. No errors exist amounting to the hundredth of a millimetre in the parts of the graduation which have been used in these analyses. When distinct vision is obtained of the graduation, a fine adjustment moves the microscope vertically till the terminal lines of the eye-piece micrometer coincide with two lines of the graduation on the eudiometer. If now the horizontal focussing movement carries the microscope forward about half an inch towards the eudiometer, the microscope will give distinct vision of the meniscus in the tube, and its level can be read by the divisions of the eye-piece micrometer, which represent the divisions on the surface of the tube carried forward optically into its interior. It would be easy to show how far the use of such an arrangement is superior to that of a cathetometer for the purpose in hand, in accuracy, in rapidity, and in simplicity of reduction for expansion of the scale.

The measured quantity of air was next transferred to a jar standing over mercury in the laboratory trough.

A quantity of hydrogen amounting to about 63 per cent of the air taken was next measured approximately, and added to the air in the jar. This amount was always the same, so that any errors which were a function of the quantity of hydrogen should be constant in amount, and should not therefore affect the differences of the analyses. 63 per cent was used in order that the last and first readings of volume might be made with the same position of the reading microscope.

After the air and hydrogen had had time thoroughly to mix they were transferred back to the eudiometer, measured, expanded, exploded, and again measured. The expansion was always the same. In the transfers mentioned there is absolutely no possibility of loss or of admixture by leakage except by gross carelessness. The only place where leakage could take place is the stop-cock at the top of the eudiometer. This stop-cock was specially made for this place, and has not yet been found to leak, though it has been tested for ten minutes against an internal vacuum before or after each analysis.

Two coincident readings were obtained for each measurement, though the result was always calculated from the last reading. To secure accurate determinations of temperature, the eudiometer and pressure tubes are enclosed in a box with plate-glass front and back, containing about 10 litres of distilled water. This is vigorously stirred, except at the instant of reading the microscope, by means of a current of air from a condensing pump driven by power. I have had no difficulty in getting the required two coincident readings in half a minute when the thermometer was rising; but when the thermometer is falling, the difficulty in getting a reading of the thermometer which shall really represent the temperature is enough to make work very vexatious, for an error of a hundredth of a degree in the difference of temperature at two measurements in the same analysis is close upon the limit of allowance.

Great care has been taken to obtain hydrogen of sufficient purity. In the earlier analyses a Bunsen's decomposing cell of the common form was used. It then often happened that the analysis made with the first hydrogen obtained after an interval of rest would give results showing a deficiency of oxygen of about a hundredth of one per cent. Often analyses had to be rejected until the cell was freed from compounds of hydrogen with zinc or carbon, which had been produced by local action at the surface of the zinc. Finally, a cell was constructed which could be every morning connected with the air-pump and exhausted of hydrogen, so as to remove these compounds of hydrogen with zinc or carbon, whether they had risen through the liquid or were still adherent to the zinc plate or dissolved in the dilute acid. The cell had a mercury stop-cock which interposed a barometric column against the leakage of air into the cell; but for additional security, the hydrogen coming from it passed through several inches of adive platinum-black. In this way I have now

* From the *American Chemical Journal*, vol. iii., No. 4.

secured a supply of hydrogen which probably never occasions a difference of a five-hundredth of one per cent in two analyses of the same sample. Experiment shows that hydrogen may safely be left standing over mercury in a clean bell-glass for a long time. I have left two samples for eleven weeks, which samples then were used in a duplicate analysis of a sample of air against a duplicate analysis of the same sample made with two samples of hydrogen just from the decomposing cell. Hydrogen was therefore sometimes used which had stood for a few days. Duplicate analyses were always made with different samples of hydrogen.

It may be observed that the corresponding measurements of different analyses were made under identical conditions. The calibration error, and the error caused by the imperfect parallelism of the reading microscope in its different positions, therefore, disappear from the differences of the analyses of different samples. The same is true of the error caused by the production of water in the eudiometer between the second and third measurements in each analysis. No correction has been applied for this error, because the distribution of the water above and below the meniscus cannot be easily determined. The amount of water adhering to the interior of the eudiometer before the commencement of an analysis has also been made always approximately the same. This has been accomplished by producing a vacuum in the eudiometer after the analysis, and the letting the mercury rise in it with a determinate velocity: when the eudiometer is clean considerable uniformity is thus obtained.

In making observation as accurate as is required for my purpose, it is very important to keep the interior of the eudiometer very clean. A little irregularity in the film of water through which the meniscus is seen will spoil the reading. My eudiometer tube is cemented into a brass fitting which rests in a seat ground for it in the bottom of the enveloping box mentioned above. The eudiometer can be disconnected, removed, washed with caustic potash and shot, rinsed out with dust-free distilled water, and replaced ready for analysis, in an hour. The accurate fitting of the ground seat makes it possible to restore the zero of the graduation on the tube to the same level within the two-hundredth of a millimetre, without even the bestowal of any thought on the matter. With this facility the eudiometer has been kept sufficiently clean for accurate reading.

It is of course possible that the mean of all my analyses with the new apparatus is affected with a measurable constant error, though no measurable error has yet been traced to any assignable source. But it is certain that the differences in the means for different periods are affected with but very small errors. During the most favourable conditions under which I have used the apparatus, taking seventy minutes for each pair of analyses of the same sample, the mean error of a single analysis was, for half a month, less than the thousandth part of 1 per cent. Having commonly to work at odd times, and more rapidly than this, the accuracy attained has been less; but, for the whole seven hundred and eighty-eight analyses made with it, the mean error of a single analysis has been less than the two hundred and eightieth of one per cent. If, then, two samples of air differ by one-fiftieth of one per cent in their contents of oxygen, the fact of a difference can be detected with a degree of probability nearly approaching certainty, at an expenditure of time not exceeding one hour for each sample.

Length of the Sparks from the Discharge of an Electric Condenser.—E. Villari.—On discharging a condenser and causing it to produce a spark or two, the length of the former is not equal to the sum of the lengths of the latter, and the sum of the lengths of the sparks is not always constant.—*Comptes Rendus*.

REMARKS ON TABLES FOR THE REDUCTION TO ZERO OF THE MEASURED VOLUMES OF GASES.*

(ABSTRACT.)

By EDWARD W. MORLEY, of Hudson, Ohio.

THE tables of Bunsen, Sutton, and others, are too bulky, from not adopting the form in which all logarithmic tables are now printed.

Many are also clumsy, giving seven decimal places of the logarithm. Four places give as much accuracy as the manipulation requires in any but the most refined work: five places more than equal the accuracy of the best work in gas analysis.

All tables for the purpose give a logarithm to be subtracted from the sum of the logarithms of the volume and tension observed. The computer, therefore, has mentally to take the arithmetical complement of the tabular number, in order then to add the three logarithms in one operation. But such tables, being intended for this one purpose only, ought to give this complement by inspection.

All tables at present published use the coefficient of the absolute expansion of air. For refined work, a second and even a third correction is then necessary, with a second and third tabular number. But by using the coefficient of the apparent expansion of air, under the conditions of measurement in analysis, the whole correction can be computed in a single operation; and with but a single tabular number. The same table may be used for ordinary work, for its use involves no more labour than that of any other table.

For the most refined work, there have to be taken into account the cubical expansion of the eudiometer, the linear expansion of the scale on which pressure is measured, and the inequality of the degrees of the mercury-in-glass thermometer. We should therefore use, for the computation of tables for the purpose mentioned the coefficient of expansion of air added to that of mercury and diminished by the sum of the cubical expansions of the eudiometer and of the linear expansion of the scale. This gives the coefficient for a degree of the ideal air thermometer, and must now be multiplied by the factor which will reduce the degrees of the air thermometer to those of the mercury thermometer.

Since the nature of the glass of which a given mercury thermometer is made affects this factor, it is best to determine the joint effect of this factor and of the correction for errors in calibration of the given thermometer by a simple process which gives very satisfactory results. A convenient volume of air is measured at a temperature near freezing-point. The same volume is also measured at about 10°, 20°, and 30°. The corresponding temperatures are carefully observed, but the apparent volumes are computed without reduction to zero. The table for temperature corrections is now computed with that coefficient which will reduce the apparent volumes at the three higher temperatures to the volume at the lower temperature. This coefficient will be different in the different intervals, partly owing to errors of calibration, and partly to the inequalities of a perfect mercurial thermometer. With such a table computed for a given thermometer, reductions may be made, even when another thermometer is used, with more accuracy than when the reductions are made from a table which does not regard the difference between the degrees of the mercury and of the air thermometer, and with far more accuracy than when the reductions are made from a table which regards only the absolute expansion of air.

* Proceedings of the American Association for the Advancement of Science, vol. xlix., Boston Meeting.

THE COST OF ELECTRIC LIGHTING BY INCANDESCENCE.

By WILLIAM CROOKES, F.R.S., &c.

THE following letter appeared in the *Times* of June 5th, 1882:—

Sir,—For more than six months I have had the principal reception rooms in this house almost exclusively lighted by incandescent electric lamps, the electricity being generated on the premises; and as so many different opinions have been given as to the expense of lighting by incandescent lamps, some saying that electricity is many times more expensive than gas, while others maintain that it is cheaper than gas, the results of my own private experience in electric lighting may not be without interest.

The dynamo machine—a small Bürgen—is driven by a 3½-horse power Otto gas engine, which under favourable circumstances will develop 5-horse power. Owing to the absolute necessity which exists in a private house in this neighbourhood that there should be no smell of unconsumed gases and no noise of machinery either in the house or out in the street to annoy my neighbours, it became necessary to add silencing chambers to the air inlet and the exhaust pipe, and to carry the products of combustion high up on to the roof. The obstructions thus put in the way of the free working of the engine necessarily affect the horse-power, so that when a further deduction is made for the power absorbed in running the machinery when no electricity is being generated, I find I have not more than two horse-power available for the production of electricity. This is far from sufficient to drive the dynamo machine to its full power, therefore I lose greatly in efficiency both in the engine and the dynamo machine. However, I have only to deal with the facts as they show themselves in my experience. The total necessary expense of the installation has not exceeded £300, including wiring the house and making the lamps, although the actual expense to me has been much more, as I had to excavate and build underground rooms for the machinery. Where stables or outbuildings are available, or if a little noise is not prohibited, a less expense will give more available electricity, and where steam power can be used the cost will be diminished fourfold. The gas engine requires five minutes' attention every day to fill the oil cups and start it. Once started, it will go on without attention for six or eight hours. It is overhauled and cleaned once a week; an engineer does this on a Saturday afternoon, at a cost of 2s. 6d.

The maximum electric current which I can get is 11½ amperes through an external resistance of 12 ohms. The lamps fed by the current are distributed as follows:—

In the library I have ten 20-candle lamps; in the dining room I have ten 20-candle lamps; in the drawing room I have a cluster of twenty-one 4-candle lamps in an electrolier in the centre of the room, and six 20-candle lamps. One or two lamps are in other parts of the house; the total number of lamps about the house being about 50. I cannot, however, have this number alight at once, as the machine as at present driven will not feed so many. It is, however, sufficient to light any two rooms perfectly, and the third partially.

Switches are placed in cupboards in each room, so as to turn any desired combination of lamps off and on. Main keys, cutting off the whole of the current at once, are placed in the engine room, and also in my laboratory at the place whence the main wires diverge to the different rooms.

Owing to inexperience in adjusting the strength of the current to the kind of lamp used, and to the variety of systems, &c., I was then testing, the breakages during the first three months were somewhat numerous. For the last three months, however, since passing the experimental stage and settling down to a definite system, I have

used lamps made by myself, and during this time only one lamp has gone.

The gas burnt in the engine when the machine is feeding its maximum number of lamps (twenty-two 20-candle lamps) is about 550 cubic feet in five hours, costing, at 3s. 2d. per thousand, 1s. 9d. Assuming that the light is required on an average five hours a night all the year round, this would come to £2 9s. a month, or £31 17s. per annum.

To obtain, not an equal amount of light, but a fairly good light from gas, to replace this amount of electric light, would take 30 gas-burners, each burning 5 feet per hour, or 750 cubic feet in five hours, costing 2s. 4½d., or £3 6s. 6d. per month, or £43 4s. 6d. per annum.

The expenses, therefore, per month stand as follows:—

Electricity—

| | |
|---|--------|
| Gas consumed in engine | £2 9 0 |
| Engineer once a week to clean and oil machinery | 0 10 0 |
| | <hr/> |
| | 2 19 0 |

| | |
|---|---------|
| Lighting by gas alone | 3 6 6 |
| Balance in favour of electricity per month .. | 0 7 6 |
| Or per annum | £4 17 6 |

I have here charged only the current expenses. Strictly speaking, I ought to charge interest and wear and tear, but these are more than counter-balanced by the incidental advantages of electric lighting. With it the ceilings do not get blackened, the curtains are not soiled with soot and smoke, the decorative paint work is not destroyed or the gilding tarnished, the bindings of books are not rotted, the air of the room remains cool and fresh and is not vitiated by the hot fumes from burnt or semi-burnt gas, while fire-risk is almost annihilated, as no lucifers are used, and the lamps are high up out of reach.

In the above statement I have compared electricity with gas as an illuminating agent. This is giving gas an unfair advantage. The twenty-one electric lamps in my drawing-room do not replace gas jets, but wax candles, whilst the incandescent lamps in the dining-room replace candles and oil lamps. The actual expense of these per night comes to three or four times the cost of electric illumination.

Moreover, I am producing my electricity at an extravagantly dear rate. The dynamo machine works only about half power, and this greatly reduces its efficiency; while Messrs. Crossley tell me that a consumption of over 100 feet of gas per hour ought to give me double the power I get out of the engine; and doubtless it would do so were it not for the back pressure produced by the silencing boxes.

When electricity is laid on to our houses as gas is, all these extra expenses and difficulties will disappear; and if, as I hope I have shown, electricity, heavily handicapped as it is in a private house, compares favourably with gas even in the matter of cost, it will necessarily be far cheaper than gas when it is supplied wholesale from a central station.—I am, &c.,

WILLIAM CROOKES.

7, Kensington Park Gardens,
London, W., June 1st, 1882.

Existence of Lithia and Boric Acid in Notable Proportions in the Water of the Dead Sea.—M. Dieulesaint.—In 1 c.c. of Dead Sea water there is a quantity of lithia sufficient to show the spectrum of this substance at least a thousand times. The same water contains also so much boric acid that it can be practically recognised in the product of a single c.c. of this water. Hence the author infers that the present waters of the Dead Sea are the residues of an inland sea analogous to the Caspian or the Karabogaz.—*Comptes Rendus*.

NOTES ON THE DETERMINATION OF
PHOSPHORIC ACID.

By CARL MOHR.

JOULIE's method for determining the compounds of phosphoric acid soluble in ammonium citrate prescribes the volumetric estimation of the ammonium-magnesium phosphate with a solution of uranium. The precipitate is to be dissolved in dilute nitric acid, the solution slightly supersaturated with ammonia, and the precipitate redissolved in dilute acetic acid. This method of treatment introduces into the solution too large a quantity of neutral ammoniacal salts, which are known to have a retarding effect on the appearance of the final reaction with potassium ferrocyanide. It is also known that large quantities of neutral calcium and alkaline salts have the same disturbing influence, rendering the results always too high. It is hence of great importance, in determinations with uranium, to keep within the boundaries which were observed in standardising the solution. This state of affairs has led the author to obtain a double standard for his uranium solution; the one for solutions poor in lime, such as superphosphates, Mejillone's guano, &c.; and the other for solutions rich in lime, like the marl phosphates. The differences are not very considerable, but still enough to have a noticeable effect in the result. Thus for superphosphates 1 c.c. of the uranium solution represented 0.0041 phosphoric acid, but for marl phosphates only 0.0039 grm.

The author has undertaken to determine, by a series of comparative experiments, the influence of combined ammonia in titrating ammonia-magnesium phosphate with uranium, and also to decide in how far this ammonium compound has a retarding action upon the appearance of the final reaction. For this purpose he prepared a solution of pure calcium phosphate in dilute nitric acid. In one series of experiments portions of 10 c.c. of this solution were mixed with sodium acetate and titrated with uranium. In the second series the lime was thrown down with ammonium oxalate, and the phosphoric acid with magnesia. In both series equal quantities of uranium solution would be consumed if the ammonium compound had no disturbing influence.

In direct titration the average quantity of uranium solution consumed was 9.46 c.c. If the phosphoric acid was precipitated as ammonio-magnesium phosphate, dissolved and titrated, the average was 5.37.

These experiments prove that there is a sufficient agreement between the two processes if in using the second or indirect method the precaution is adopted of allowing the precipitate and filter to stand for some time in a warm place, so that the free ammonia of the washing water may evaporate.

In vol. xix., p. 150, of the *Zeitschrift*, the author has communicated a process for determining phosphoric acid with uranium in presence of iron. This process he has since then frequently proved, and can recommend it to technical analysts as accurate. The procedure suggested is found tedious and disadvantageous, so that he has felt induced to adopt a modification. In his original memoir he proposed to throw down the ferruginous solution of phosphate partially with uranium, and then to add so much potassium ferrocyanide as suffices for transforming the ferric phosphate. This transformation is often incomplete if but little iron oxide is present, as in animal charcoal and guano. It is hence every way better to throw down the iron with potassium ferrocyanide before precipitating the phosphoric acid. Filtration is in either case unnecessary. Instead of precipitating the iron with pulverised potassium ferrocyanide, as directed in the author's first memoir, he prefers a 5 per cent solution, which is introduced into a small bulb-pipette drawn out below to a fine orifice. To regulate the outflow of the liquid a glass tap is adapted below the bulb.

When precipitating a ferruginous phosphatic solution it

is needful to ascertain previously how many drops of the ferrocyanide solution are necessary. The solution is dropped in till a drop of the liquid gives a faint reddish or brown colouration. To a second portion there are added one or two drops fewer, and it is ascertained by a second test with uranium solution if the precipitation-point has been reached. It is necessary to count the drops exactly. In metallurgical or mining establishments where ores of the same class are always examined, a single determination of the number of drops is sufficient to show how much ferrocyanide solution is always to be used for the precipitation of the iron.—*Zeitschrift für Analyt. Chemie.*

ON THE
ALKALINITY OF POTASSIUM MONOCHROMATE
AND ON THE
TRUE COLOURING-MATTER OF LITMUS.

By M. RICHTER.

POTASSIUM monochromate in solution reacts upon turmeric and litmus like an alkali. This fact is the more remarkable as it is a neutral, well-crystallised salt, and its behaviour in other respects cannot be harmonised with alkalinity. This alkalinity may be explained either as due to a mechanical admixture, derived from the preparation of the salt, or to a peculiarity of a chemical nature and essential to the existence of the compound, or to the oxidising action of chromic acid.

Of these three views the third has been proved by the author, by means of very simple experiments. The first has been refuted by the following experiment:—Pure potassium monochromate was dissolved in water and precipitated with alcohol six times in succession, by which process any caustic alkali would be removed, since potassium hydroxide is soluble in alcohol. The salt, after being thus purified, reacted as before strongly alkaline. The alkalinity is therefore due only to the behaviour of the chromic acid as an oxidising agent. To determine this point litmus, turmeric, and phenol-phthaleine were applied comparatively. The solution of the salt gave, with the red colour of the litmus, a green mixed colour, and with red litmus paper a blue-green. Turmeric tincture and paper were turned to a permanent dark red-brown. Solution of phenol-phthaleine and paper saturated therewith remained unaffected. But if a trace of alkali was added to the monochromate the well-known intense red colouration of phenol-phthaleine was at once apparent. This indicator is decidedly preferable to the others.

Herewith a proof is furnished that potassium monochromate does not exert an alkaline reaction in the first moment, as in this case the reaction of phenol-phthaleine would appear, but the alkalinity is first produced by the influence of the chromic acid upon the colouring-matter. The author advances here two suggestions which both seem very hazardous, as further research is needed to give a positive result.

1. The chromic acid oxidises the colouring-matter so as to produce coloured compounds.
2. In the oxidation of the colouring-matter the chromate is decomposed, and caustic alkali is liberated, which acts upon the colours.

The former hypothesis is preferable if the action of the chromate is kept in view. If red litmus paper is spotted with a solution of the chromate it turns green at the edges. In other words, the chromic acid oxidises the red colour to a blue compound, which forms a green with the yellow colour of the excess of the salt. The blue litmus is therefore a product of the oxidation of the red, which must be regarded as the original colouring-matter.

Another proof that the blue is a compound derived from the red is already known. If blue litmus solution is pre-

served in a closed bottle the liquid loses its blue colour and acquires a reddish tint. If poured upon a plate, so that the air has everywhere access, the blue colour is soon restored. The air exerts here, without doubt, an oxidising action, though less rapid and energetic than that of chromic acid.—*Zeitschrift für Analyt. Chemie.*

ON THE HYDROSULPHATE OF NICKEL SULPHIDE.

By M. H. BAUBIGNY.

IN the action of sulphuretted hydrogen upon a solution of nickel sulphate the author describes the progressive formation of the metallic sulphide to the existence of a nickel sulphide hydrosulphate, a compound which in consequence of its stability being variable with the temperature and the conditions of the medium would act by its successive decompositions and reformations, and determine thus redactions which sulphuretted hydrogen alone cannot produce under the same circumstances.

It is found on filtering a liquid in which nickel sulphide has been thrown down by the action of sulphuretted hydrogen that, if this filtration is not effected until the sulphide has been deposited, the odour of the sulphuretted hydrogen becomes more penetrating on pouring upon the filter the portion of the liquid charged with suspended sulphide. It is therefore not surprising that the analysis of this precipitate, washed and dried, all causes of apparent alteration being excluded, has never yielded results differing from the exact composition of nickel sulphide, NiS. As the hydrosulphate cannot be isolated, the author proves its existence indirectly.

In one of his experiments the excess of sulphur over and above the weight answering to the composition of nickel sulphide has been as much as 14 per cent. This excess of sulphuretted hydrogen can only exist in the presence of the nickel sulphide, and it is by no means due to a simple physical condensation by the sulphide. If the same experiment is repeated with zinc the same excess of sulphur is found. The author has shown that nickel sulphide acts chemically upon the solution of acid nickel sulphate in presence of sulphuretted hydrogen, whilst zinc sulphide does not act in the same conditions as nickel sulphate, as inversely the author shows that zinc is not precipitated from a solution of acid sulphate in the presence of sulphuretted hydrogen by the metallic sulphides which throw down nickel under the same circumstances. If nickel sulphide and zinc sulphide remain sulphuretted hydrogen in consequence of simple condensation, that is to say, in the same physical state, both ought to act chemically in the same manner. If they act differently it is because there is more than a difference of physical state. Sulphuretted hydrogen forms with zinc sulphide and nickel sulphide true combinations, i.e., hydrosulphates of sulphide. Experiment confirms thus the theoretic prevision announced by M. Berthelot relative to the existence of the hydrosulphates of sulphides.

The causes which govern these differences of action of various metallic sulphides upon the solutions of the acid salts of other metals in presence of sulphuretted hydrogen will be the subject of a special memoir.—*Comptes Rendus.*

Laws of the Solubility of Carbonic Acid in Water under High Pressures.—S. Wroblewski.—The temperature remaining constant, the coefficient of saturation (i.e., the quantity of gas measured in c.c. at zero and under the pressure of one atmosphere), dissolved in 1 c.c. of water, increases much less rapidly than the pressure, and tends towards a certain limit. If the pressure remains constant, this coefficient augments as the temperature diminishes.—*Comptes Rendus.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 1, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

The following certificates were read for the first time:—T. Hughes, H. Jordan, L. Reed, E. S. Spalding, P. G. Sanford, J. E. Stead, C. J. Waterfall.

The PRESIDENT then called on Mr. WARINGTON to read a paper "On the Determination of Nitric Acid in Soils." As to the taking a sample of the soil, a detailed description of which the author promises to give on a future occasion, it is important to sample the sub-soil as well as the surface, and to take the samples after dry weather. Thus Doussingault, August 9, 1856, found that after dry weather the surface soil of a kitchen garden contained nitrogen as nitrates = 2.2 per million; a few weeks after, August 29, rain having fallen, the nitrogen = 1.2 per million; October 10, after dry weather, the nitrogen was 4.3 per million. It is necessary to dry the sample speedily, else nitrification proceeds. Drying at 100° may occasion a loss of nitrates in proportion to the wetness and mass of the soil and its richness in organic matter. Drying at a high temperature also greatly increases the soluble organic matter in a soil. The plan adopted by the author is to break up the soil to small pieces, place these in paper trays, and dry in a stove at 55° (the temperature at which Schlessing and Müntz state that nitrification ceases). Soils thoroughly dried in dry air seem to undergo very little change by keeping. The method commonly used to prepare an extract of the soil is to shake 500 or 1000 grms. of soil with its own or twice its own weight of water, and take a known portion of the solution for analysis. This method is tedious and yields a very dilute and turbid extract. The author extracts 200 to 500 grms. of dry powdered soil with cold water, on a vacuum filter, until 100 c.c. have passed through. This extraction takes from ten to forty-five minutes, and all the soluble salts can be extracted with the utmost ease. Thus 7 lbs. of dry powdered soil, in a column 8 inches deep, were extracted with cold water. All the chlorides and 99 per cent of the nitrates present appeared in the first 150 c.c. of extract. In dry soil, if free from fissures, a descending column of water dissolves all soluble salts at its lower edge, and pushes the solution before it until an area of discharge is reached: thus the salts are obtained in the form of a concentrated solution. If, on the other hand, wet soil is employed, the whole of the water must be expelled to obtain all the soluble salts present, and a large and dilute extract is therefore obtained. For the analysis of the extract, the Crum-Frankland process was at first employed; the greater part of the organic matter has to be removed by treating the highly concentrated extract from the soil with strong alcohol, the filtrate being evaporated to dryness and dissolved in a small quantity of water. If a drop of dilute hydrochloric acid be introduced with the purified soil extract into the shaking tube, to make the action on the mercury more energetic, very fair results, if the amount of nitric acid be not too small, may be obtained. The determination of the nitric acid is now made by a modification of Schlessing's method, the nitric oxide being measured. When this method is used no purification of the soil extract is required, and much larger quantities of nitrate may be operated on. The results obtained by this method are rather higher than those yielded by the Crum-Frankland process.

The PRESIDENT said that the determination of the nitrogen in a soil was of the utmost importance, but until the method of collecting a true sample of the soil was introduced, it was difficult to know what the results ob-

tained really represented. When at Rothamsted a balance of the nitrogen given to the land as manure and the quantity present in the crops was first struck, it was found that only one-third of it could be accounted for in the crops. It was suggested that the excess accumulated in the soil, but it has been proved that this accumulation varied not with the quantity of manure applied, but with the growth on the soil; with a bad growth no accumulation took place. This question as to the ultimate fate of the nitrogen lost was one of the greatest importance in agricultural chemistry.

Dr. RUSSELL then read a paper "On a Spectroscopic Study of Chlorophyll," by Dr. RUSSELL and Mr. LAYRAK. The authors have endeavoured to throw some light on the properties and nature of this body by following out its spectroscopic changes. The colouring-matter was usually extracted by a mixture of alcohol and ether. By chlorophyll the authors mean the body or bodies giving a particular absorption-spectrum, and they have assumed that a particular absorption-spectrum is a complete identification of a particular substance. In all leaves investigated by the authors, chlorophyll exists, and is extracted by alcohol and ether, the solution giving the well known absorption spectrum of four well-marked bands. This substance is exceedingly sensitive to the action of acids, a mere trace of hydrochloric acid altering the absorption-spectrum, causing one band to disappear; the addition of a further quantity of acid gives another well-marked absorption-spectrum. The action of hydrochloric acid takes place in two stages, both characterised by absorption-spectra. The first is called by the authors the "half-acid" spectrum; the second the "acid" spectrum. This action is not peculiar to hydrochloric acid, but is also brought about by sulphuric and nitric acids. If tartaric, citric, or oxalic acid be used the action ceases at the half-acid stage. The same half-acid spectrum can be obtained by evaporating to dryness a solution of chlorophyll at 80°, or above: the residue on re-solution gives the half-acid spectrum. If a chlorophyll solution be precipitated by alum, it is converted into the half-acid substance, but basic lead acetate precipitates the chlorophyll unchanged. The leaves of some plants, as the vine, &c., yield such an acid extract that the chlorophyll is converted into the half-acid modification; by adding calcium carbonate during the extraction, a solution of normal chlorophyll is obtained. Alkalies produce a characteristic change in the absorption-spectrum of chlorophyll; all the bands disappear except the well-marked band in the red, which spreads to the blue. By the further action of caustic potash or soda this broad band splits into two. The half-acid modification gives with alkalies a spectrum distinct from that just described. The one-banded spectrum produced by the action of alkalies can also be obtained by precipitating chlorophyll with copper sulphate, washing the precipitate till free from copper, drying, and dissolving in alcohol and ether. This one-banded modification seems to be most stable; it can be dissolved in strong sulphuric acid and re-precipitated unaltered by dilution with water. The authors have also made some experiments as to the action of light on these substances. In conclusion the authors referred to the various tints of green in young and old leaves, and suggest that the light tint might be due to dilution of the chlorophyll.

Some photographs, by Capt. ABNEY, of the various absorption-spectra were exhibited.

After a short discussion, in which Dr. Schunck, Prof. Lankester, and Messrs. Smece and Cross took part, the Society adjourned to June 15, when a ballot for the election of Fellows will be held, and the following papers read:—"Note on the Preparation of Amido- β -naphthol and β -naphtha-quinone," by C. E. Groves; "On Hematein and Brazilin," by J. J. Hummel and A. G. Perkin; "On the Determination of Nitric Acid as Nitric Oxide by means of its Reaction with Ferrous Salts," Part II., by R. Warington.

NOTICES OF BOOKS.

Spon's Encyclopedia of the Industrial Arts, Manufactures, and Commercial Products. (Division V.) Edited by C. G. WARNFORD LOCK, F.L.S. London and New York: E. and F. N. Spon.

WE have here the concluding part of Messrs. Spon's great undertaking. In the preface attention is justly called to the prominence which has been given to raw commercial products. These are here dealt with on a more comprehensive scale than in any similar publication in the language, and the information thus given cannot fail to be valuable to, and valued by, a large part of the community. The oils and fats, gums, resins, starches, tanning, and dye-ware have been described with remarkable care and fulness, and even the less known—and for the present less important—articles are not overlooked. The complaint is made, not without a show of reason, that the average British manufacturer is ignorant of the needs of every industry but his own. Hence he is apt to overlook serviceable raw materials, and to be ignorant of possible modes of utilising his refuse or waste. The profitable application of waste is, indeed, a subject which has been in view through the entire work, and not a few suggestions have been thrown out in this direction. We have, however, sometimes doubts whether the public is not too sanguine in its expectations of the benefits to be derived from the utilisation of waste. Reference is often made in speeches and in the press to the benefit which the alkali manufacturers have derived from having been compelled to condense their hydrochloric acid instead of turning it out into the air; but, in consequence, the supply of hydrochloric acid has become so abundant that it is scarcely marketable. It has been used in the manufacture of chloride of lime to such an extent that the demand for that article is nearly outstripped by the supply. Some one is therefore wanted who can point out a use for this acid on the spot where it is produced. Before the by-products and refuse of our chemical works can be profitably dealt with inland, transport must be much cheaper than it is. But as Mr. Peter Spence, of the Manchester Alum Works, has most ably shown, exorbitant and arbitrary rates are charged by the railway companies, who have been foolishly permitted to get many of the canals into their hands, and thus do away with all chance of competition.

Turning to the various substances dealt with in this volume we notice a rather brief section on pigments. White-lead is dispatched in five lines, only one of the various processes for its manufacture being described, and that, too, in the briefest manner. Brown pigments, such as the umbers, are omitted entirely. Under yellows we miss cadmium-yellow, so valuable for its permanence, and the lemon and orange varieties of chromate of lead have also been overlooked. The machinery for grinding paint is figured and described at considerable length.

Pottery in its various branches is discussed in an extensive article, which is abundantly illustrated.

The section on "resinous and gummy substances" is one of the longest in the entire work, extending to upwards of 70 pages. We should think that these two great groups of vegetable products had better have been treated separately. The distinctions between gums and resins are indeed pointed out in the beginning of the article, but as they are afterwards described together alphabetically it is possible that the reader will sometimes feel at a loss. The tabular scheme for the detection of true resins, gum-resins, and balsams, taken from Hirschsohn, will be of great utility in the analysis of medicines, varnishes, and other mixtures of organic matter.

Common salt is very ably treated from a chemical and geological as well as from an industrial point of view. We find mention of the curious fact, that if the whole of the known deposits of rock-salt in the world were to be added to the waters of the ocean they would but raise its

standard of saltiness to an insignificant extent. The bulk of rock-salt which the evaporation of the entire ocean would yield is estimated at 4,419,360 cubic miles.

On the eastern coast of the Caspian a very curious phenomenon is in progress. The Kara Boghaz is an estuary nearly separated from the main body of the sea by a bank through which there is an inlet. The evaporation from this gulf is so great that a current continually sets in from the main body of the Caspian; and as there is no return current, the water of the gulf becomes more and more saliferous, and a deposit of salt is in course of formation. In process of time this gulf will be cut off from the Caspian, and will then be dried up and become an extensive deposit of salt. What renders this supposition the more probable is that there are along the shores of the Caspian, but now detached from it, several salt lakes in various stages of desiccation. These phenomena may be commended to the notice of all who are anxious to form an internal sea in the Sahara.

In the section on silk there is a careful account of the product of the common or domesticated silkworm, and of the so-called wild silks which have been of late so carefully examined as to their industrial capabilities by Mr. T. Wardle, M. A. Wailly, Major Coussmaker, and others.

Under the head "Skins" we find mention of the curious fact that salmon-skins make leather as tough as wash-leather and about the thickness of dog-skin. The importation of goat-skins from British South Africa amounts in a single year to upwards of 900,000. That so many goats exist there fully explains the treeless and arid state of most of that region.

The soap manufacture is ably and fully described. We find mention of the adulterations of soap, but it is brought under the notice of the reader that a soap free from any impurities may do mischief if it has not been skillfully and carefully prepared. Unsaponified fats and free alkali are often the cause of much trouble to woollen manufacturers, dyers, &c. An instructive case is given where a good soap had produced unsatisfactory results because the consumer's workmen had not taken the trouble to dissolve it, but had applied to cloth—probably in fulling—a solution containing undissolved pieces. This instance shows how much chemical manufacturers are at the mercy of careless, or probably malicious, workmen, and may explain, if it does not justify, the questionable means sometimes used to secure the good will of the latter.

The chapters on starches and on the astringent or tanniferous drugs are of a satisfactory character. The determinations of tannin in the various wares are accurate as averages, and agree with the comparative efficiency of the various drugs in practice. Till recently the published analyses of such products were wild in the extreme.

The work is provided with a most elaborate index. In surveying this encyclopædia as a whole we can have no doubt whatever as to its great value. The various articles in the work are of course not equal in thoroughness and accuracy. Some of them may perhaps be considered unnecessarily long, whilst others might have been usefully extended. But the reader finds here abundance of useful information which no other work in the language would afford.

Geological Map of Sutherland. By M. FORSTER HEDDLE, M.D., President of the Mineralogical Society. Edinburgh: W. and A. K. Johnstone.

THIS excellent Map is the twenty-first number of the *Mineralogical Magazine*, and is arranged to fold up for the convenience of the travelling geologist, who with such a guide will find the study of the Sutherland formations much facilitated. The scale is two miles to the inch; the engraving is very clear, and, besides, the colouration showing the various leading strata, the dips, anticlinal lines, and faults are indicated.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 20, May 15, 1882.

Synthesis of Various Organic Compounds by means of the Electrolysis of Water and of Acid, Alkaline, and Alcoholic Solutions with Electrodes of Carbon.—A. Bartoli and G. Pappasogli.—In researches on galvanic polarities, one of the authors had observed that coke, charcoal, or graphite, under the action of the current, is disaggregated. Whilst the electrolyte is blackened more or less according to its nature and that of the carbon, the gas evolved at the positive pole was below the normal volume. The immediate object of the present researches was to ascertain what became of the oxygen. They experimented with graphite, coke, and wood charcoal purified by treatment with chlorine at high temperatures. With coke or charcoal as positive electrode, and distilled water as an electrolyte, they had to employ a battery (=1200 Daniells) to overcome the resistance of the voltameter. After the current had passed for two days the electrolyte had a brown colour and a slightly acid reaction. The battery was then reduced to 100 Bunsen elements, and after ten days 20 Bunsens were sufficient, which aided for thirty days. The water became black, the electrode, which weighed about 500 grms., was totally disaggregated, and at the bottom of the voltameter there was a thick muddy deposit. On analysing the electrolyte there was found mellitic acid and some of its derivatives, such as the hydro-mellitic, pyro-mellitic, and hydro-pyro-mellitic acid. In the muddy deposit there was found a black matter, soluble in hot water and alkalies, but in soluble in most mineral acids and the majority of organic solvents. They name this substance mellogen, since, on oxidation it produces the acids of the benzo-carbonic series. Its analysis leads to the formula $C_{14}H_{10}O_4$.

Aperiodic Galvanometer.—MM. Deprez and d'Arsonval.—This paper cannot be intelligibly reproduced without the aid of the two accompanying figures.

Mechanism of the Putrid Fermentation of the Proteic Matters.—A. Gautier and A. Etard.—At the outset of the experiments the muscles of beef and of horse-flesh were acid and inodorous. After some days, even when the matter was entirely protected from vibrations, the muscular matter gave off an acid odour, and without disintegration emitted a clear syrupy liquid, which seemed to result from the digestion of the muscular flesh due to a peculiar ferment. This liquid, analogous to a thick serum and almost colourless, contains 21 to 22 grms. per litre of albumen, coagulable by heat, and a very minute proportion of casein. In this medium the lactic and butyric fermentations were set up under the influence of large three- or four-jointed Bacilli, of eight-jointed Bacteria, and of movable granulations. The gases given off were carbonic acid, nitrogen, and hydrogen, the two former of which increased from the seventh to the twenty-sixth day, whilst the latter decreased to a trace. There was a mere trace of sulphuretted and phosphoretted hydrogen, but no hydrocarbons. With the liberation of nitrogen the true putrid fermentation sets in. The great Bacteria and Bacilli disappear, and are succeeded by small Bacilli, and with pundiiform ferments, which attack the albumenoid molecule, disengaging carbonic acid and ammonia. The great mass of the molecule passes into the state of leucines and leucines, accompanied by a small quantity of phenol, scatol, indol, and, according to the author's researches, of carbamylamines and ptomaines.

A Case of Isomerism of Bichlorated Camphor.—P. Cazeneuve.—The bichlorated camphor discovered is more

soluble in water than the normal kind. It liquefies on contact with chloral hydrate like camphor, which the normal kind does not. The isomer is less stable than the normal product.

Purpuro-galline.—P. de Clermont and P. Chantard. —Purpuro-galline may be obtained by exposing to the air a watery solution of pyro-gallol upon platinum black. It easily crystallises from its alcoholic solution, and forms fine needles of a deep brown colour. It melts at 256°, and sublimes with decomposition at a little higher temperature. Soda and purpuro-galline combine in alcoholic solutions, forming a sodium purpuro-gallate, which is deliquescent, very soluble in water, and if heated in a closed vessel with ethylic iodide, yields the ethylic derivative of purpuro-galline. The authors have further examined the behaviour of purpuro-galline with bromine, hydrochloric, sulphuric, and hydriodic acids, and acetic anhydride.

Dimorphism of Stannic Acid.—Michel Levy and L. Bourgeois. —Stannic oxide is dimorphous, like zirconia, and presents a crystalline variety analogous to tridymite.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 4.

Composition of the Rain and Drainage Water at Rothamsted.—Messrs. Lawes, Gilbert and Warington.—From the *Journal of the Royal Agricultural Society of England*.

Absorptive Power of Humous Media.—Dr. A. König. —The absorptive phenomena observed may be explained by the assumption of the joint action of chemical and physical processes. Humous substances appropriate alkali from alkaline solutions for the most part mechanically. The absorption increases as the moor contains less mineral matter. The absorption of potassium or ammonium from neutral saline solutions rises and falls with the mineral percentage of the moor. Chlorine and sulphuric and nitric acids appear not to be absorbed by moor soils, and phosphoric acid only in as far as mineral matter is present, with which the acid may form insoluble salts. Moor soils can absorb the water from an aqueous saline solution, rendering it more concentrated.

Manurial Experiments in Vineyards.—Dr. A. Stutser. —In three cases out of four chemical manure gave a heavier crop than farm-yard manure. No difference was observed in the quality.

Researches on the Influence of Space on the Development and Yield of Cultivated Plants.—Prof. E. Wollny (a Continuation). —The results of the author's experiments are, seeds sown by the drill give a better return, both in quality and quantity, than those sown broadcast, and that at a smaller outlay for seed.

The Primary Effects of Light upon Vegetation.—M. Pringheim. —The author rejects the gas-analytical method of treating this question, and prefers to observe the visible changes which the light produces in the cells within a short time, under the eye of the observer. The effects of intense light upon the plant-cell are dependent upon the presence of oxygen.

On Anhydrous Milk-Sugar, and on the Determination of Sugar in Milk.—Dr. M. Schmäger. —Solutions of milk-sugar evaporated in the water-bath leave the sugar not in its ordinary crystalline state, but anhydrous. Such, if dissolved immediately, show an abnormally feeble rotation.

Moniteur Scientifique, Quesneville.
May, 1884.

The Rosaniline Question.—A. Pabst. —It has long been known that commercial rosaniline as extracted from the product of the reaction of arsenic acid with aniline

and toluidine, is a mixture of two nearly allied bodies. M. Rosenstiehl in an investigation published about twelve years ago announced three such bodies, but since the recent researches of Fischer only two are admitted, —para-roaniline, isomeric with the mauvaniline of Girard and De Laire, derived from a mixture of aniline and para-toluidine; the other, ortho-para-roaniline is formed from aniline and the two toluidines. These two rosanilines co-exist in the hydrochlorate sold under the name of "fuch-sine"; but one of them, ortho-para-roaniline, is only proper for the manufacture of rosaniline blue, the other giving merely a greyish violet product. Hence manufacturers have long sought to separate them, utilising the ortho-para- for blue, and converting the para-roaniline into magenta. The first process, employed as far back as 1855 by Girard and De Laire, consists in leaving the acetates of the bases to settle; that of para-roaniline remains syrupy, and may be dried in amorphous crusts; that of ortho-para-roaniline crystallises, and may be separated by draining. The solutions of the two rosanilines are closely alike; that of para-roaniline inclines a little more to the violet, but in dyeing the shades obtained are practically identical. M. Monnet boils for two or three hours the commercial magenta with moist rosaniline prepared by precipitating a portion of the same magenta with an alkali; the para-roaniline displaces the ortho-para- compound, and forms a soluble salt, whilst the other becomes free and remains upon the filter. After boiling in pure water it is washed in hot ammoniacal water, and serves then for the manufacture of blue. M. C. Girard gives two other methods of separation founded upon the solubilities of these bases. M. Fischer thinks that these two rosanilines are identical with the red bodies obtained by oxidising the leukanilines, which these chemists have obtained synthetically, setting out from triphenyl-methan and ortho-cresyl-diphenyl-methan. The author has expounded the ingenious theory which arranges the artificial colours in five groups: The substituted phenols, anthracene, triphenyl-methan, comprising rosolic acid, rosaniline, and its derivatives, malachite green and the phthaleines, which are the link between triphenyl-methan and anthracene; the indulines and safranines and the azo- compounds. The rosaniline may be obtained by the oxidation of a mixture of aniline and toluidine; by the oxidation of pure aniline upon stannic chloride; by the action at 150° of nitrosyl chloride upon aniline mixed with toluidine, and by the action of aniline upon nitrobenzol in presence of certain chlorides. It is very probable that rosaniline when transformed into leukaniline by reducing agents, undergoes a transformation; leukaniline and rosaniline not having the same constitution. The author does not see why there may not exist several leukanilines and several rosanilines with several rosolic acids corresponding.

Analysis of Phosphates.—A brief account of the methods adopted at the Congress of Halle in December, 1881, for fixing upon a general process for determining phosphoric acid in the different states in which it occurs in manures.

Soluble and Insoluble Modifications of the Ferment of the Gastric Digestion.—A. Gautier. —A continuation of a memoir of a physiological character.

Cadaveric Alkaloids.—A summary of the principal characters of the ptomaines.

Antiseptics.—R. Koch. —The author has endeavoured to ascertain what agents are able to destroy the spores of bacilli, how they behave towards the microphytes most easily destroyed, such as the moulds, ferments, and micrococci, and if they suffice at least to arrest the development of these organisms in liquids favourable to their multiplication. His results with phenol, thymol, and salicylic acid have been unfavourable. Sulphurous acid and zinc chloride also failed to destroy all the germs of infection. Chlorine, bromine, and mercuric chloride gave the best results; solutions of mercuric chloride, nitrate

or sulphate diluted to 1 part in 1000 destroy spores in ten minutes.

New Process for the Preservation of Meat.—The process in question is Jones's Patent and consists in the injection of a solution of boric acid into the veins.

Note on Tincture of Iodine.—J. Casthélas.—The author proposes to obtain a permanent tincture of iodine by adding a small quantity of potassium iodide which prevents the formation of hydriodic acid.

Determination of Sulphurous Acid in Wine.—M. Hass.—From the *Berichte der Deutsch. Chem. Gesell.*

Cattle Foods and Oil Cakes.—The author strongly recommends cocoa-nut oil cakes.

New, Easy, and Economical System of rendering Wines Effervescent.—A. Carpene.—The author saturates wines, &c., with carbonic acid whilst exposed to a low temperature.

Transformation of Xanthine into Theobromine and Caffeine.—E. Fischer.—The author extracts guanine from guano, transforms it into xanthine by treatment with nitrous acid, and then converts the xanthine into theobromine or into caffeine by methylation.

Communications from the Laboratory of the Chemical School of Mulhouse.—These consist of a memoir by M. E. Noelling on certain derivatives of rosaniline; a paper by the same author on the dissociation of trichloro-sulpho-methyl chloride; and a memoir by MM. Noelling and Bourcart on the action of sulphuric acid upon proto-catechuic acid.

Industrial Society of Mulhouse.—Session of March 8, 1882.—The Committee voted a medal to MM. Hofmeyer and Co., for their improvements in the purification of blood albumen.

Note on Oxalic Acid.—M. Péter, J.L.—An account of the preparation and properties of the monohydrated and trihydrated acids in a state of purity.

The Use of Zinc Chloride as a Reagent for Certain Alkaloids.—A. Jorissen claims the use of this reagent as having been first proposed by himself in the *Bulletin de l'Académie Royale de Belgique* for 1879.

Detection of the Sophistication of Olive Oil with Cotton Oil.—M. Zecchini.—The author mixes in a test-tube 5 c.c. of the oil with 10 c.c. of pure nitric acid at sp. gr. 1.40. The tube is well shaken up and left to stand for five or six minutes. Pure olive oil only takes a faint greyish brown colouration with yellowish reflections; pure cotton oil takes an intense coffee-brown, almost black. The mixtures take intermediate shades. It is necessary to operate always under the same conditions, and to observe the colours after the lapse of the time specified, and not later, as the colour of olive oil deepens on standing.

Die Chemische Industrie. Vol. 5, No. 3.

Appendix to Prof. G. Lunge's Report to the General Meeting of the Association of German Alkali Makers.—As regards the determination of hydrogen and ethylene in gaseous mixtures, the author has devised an apparatus which takes up little more room than that of Orsat, and requires only three minutes for a hydrogen determination. In addition to the three ordinary U-tubes of Orsat's apparatus there is a fourth, which is filled with water, and serves to receive the gaseous mixture which has been passed over the combustion-capillary. The latter, filled with palladised asbestos, is introduced between the last U-tube and a special cock, so that the triple cock can subserve its ordinary purposes. A small spring-lamp is fixed on a movable support so that it can be brought in a moment under the capillary, which should be warmed but slightly. The combination of oxygen and hydrogen or the combustion of ethylene is effected per-

fectly in a single passage through the warmed palladium asbestos, whereon the gas is driven back into the measuring tube, and its contraction is determined. Concerning the solution of pyrites there prevails still a difference of opinion as to whether nitric acid or *aqua regia* should be used. Fresenius directs "red fuming nitric acid," without specifying its exact strength. Most readers would understand the strongest acid at 1.50 sp. gr. Lefort's mixture is also mentioned, consisting of 1 part strong hydrochloric acid and 3 parts "very concentrated" nitric acid. The author has used for some time a similar mixture, the nitric acid being at 1.40. In comparative experiments which he has instituted, it appears that for opening up pyrites nitric acid at 1.42 sp. gr. should be used. Still preferable is a mixture of nitric acid of the same strength with one-third its volume of hydrochloric acid, to prevent the separation of sulphur or to promote its oxidation. As regards the determination of alkaline carbonates in presence of hydrates, where there is much caustic alkali and little carbonate (as in commercial lump caustic) titration with phenacetoline is not to be recommended, the barium chloride method being more accurate. When caustic predominates, but the quantity of carbonate is still considerable (as in caustic lye), phenacetoline gives better results, and in crude soda lyes, where the carbonate predominates, titration with phenacetoline is preferable if the lyes are not too deeply coloured. In titrating the oxidisable sulphur compounds in crude soda-lye with solution of iodine, the author prefers direct titration of the lye, which is previously much diluted and acidified with acetic acid. Prof. Lunge has examined Schœpff's modification of Hurter's process for the titration of alkaline ferrocyanides with copper sulphate. The original process, in which oxidation is effected by means of chloride of lime, and the excess of chlorine is expelled by gentle heating, gives results not very constant or accurate, whilst sufficiently accurate results are obtained if a concentrated solution of chloride of lime or bromine water is added from a burette till drops of dilute iron chloride are no longer turned blue. A second portion is then mixed with the same quantity, it being necessary to make but few spotting tests, and is then titrated with solution of copper sulphate till a drop gives a distinct rose colour with dilute solution of ferrous chloride.

Journal für Praktische Chemie. Nos. 5 and 6, 1882.

Reactive Value of the Components of Acids.—N. Menschutkin.—The formation of a chain of carbon atoms, and therefore the substitution of the hydrogen-valence by the carbon valence, in formic acid occasions a decrease of the speed of etherification and an increase of its limit. The magnitude of these changes is determined by the following propositions:—The formation of a chain of two carbons involves the smallest change, as in this case in acetic acid the three valences of the one carbon atom are saturated by hydrogen. The formation of a chain of several carbon atoms, setting out from acetic acid, can take place in various ways. If on one carbon atom of acetic acid one hydrogen valence is substituted by a carbon valence, as is the case in the formation of the primary acids, the speed of etherification is lessened and its limit is increased. In the formation of the normal primary acids the limit of etherification is regularly increased for each carbon atom which enters the chain. So long as the acid remains primary, complex, and annular combination are of subordinate influence. If in one carbon atom of acetic acid two hydrogen valences are substituted by two carbon valences, the speed of etherification in the secondary acids formed is still more decreased and its limit is further increased, and these changes are relatively more intense than those which occur in the formation of primary acids. The decrease of the speed of etherification and the elevation of its limit reach their

maximum when all the three hydrogen valences of the one carbon atom of acetic acid are substituted by carbon valences, as is the case in the formation of the tertiary acids.

Influence of the Molecular Weight of Homologues upon the Course of Incomplete Reactions.—N. Menshutkin.—If a reaction is complete homologues participate therein in varying proportions of weight, according to their molecular weights. Thus bromine combines with increasing weights of the homologous hydrocarbons of the ethylene series. The law of homology holds good also in incomplete reactions.

The Behaviour of Tellurium with Sulphuric Anhydride and Sulphuric Hydrates.—Rudolph Weber.—The author has examined the peculiar amethyst red compound formed when tellurium is dissolved in sulphuric acid. The compound obtained with sulphuric anhydride, TeSO_3 , is analogous to the compounds obtained under similar circumstances with sulphur and selenium.

Behaviour of Iodine with Sulphuric Anhydride and Sulphuric Hydrates.—R. Weber.—Iodine and sulphuric anhydride combine in three proportions, in which the iodine forms respectively, 34, 61, and 76 per cent.

Mercury Fulminate.—E. Carstanjen and A. Ehrenberg.—The authors examine the action of hydrochloric, hydrobromic, hydroiodic, and sulphuric acids upon fulminating mercury, as also its behaviour with sodium amalgam.

Anthology of Modern Chemical Utterances.—Incapable of useful abstraction.

Hard Bronzes of Ancient Nations.—E. Reyer.—The bronzes employed for weapons and tools were free from lead and zinc, but contained in addition to copper and tin, small quantities of nickel, iron, phosphorus, and sometimes cobalt.

The Carbonic Ethers of Iso-hydro-benzoin.—M. Wallach.—This substance has the composition $\text{C}_{12}\text{H}_{12}\text{O}_3$, and melts at 110° .

Behaviour of Ortho-nitro-oxy-phenyl-acetic Acid with Reducing Agents.—Alex. Thate.—A preliminary communication. On treating the sodium salt of this acid with sodium amalgam, the author obtained azo-ortho-oxy-phenyl-acetic acid, and other bodies which he purposes to examine.

Remarks on Two Chemical Publications.—M. Nencki.—This paper consists of questions of originality and priority.

Dinitro-Compounds Obtained from Phenols.—G. Chancel.—From the *Comptes Rendus*.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 2, May 13, 1882.

Vesicular and Encyclid Crystallisation.—Dr. C. Brame.—The author concludes that the ray of influence of particular gravitation in cytogenous and encyclid crystals of vesicular origin is equal to the square root of the radius of the terminal cyclide.

Characteristic Reaction of Cotton Oil as compared with Olive Oil.—Marco Zecchini.—The author treats the oil in question with nitric acid at sp. gr. 1.40, and which must be pure and colourless. He mixes 10 c.c. of acid and 5 of oil. The two liquids are mixed in a test-tube, the mouth of which is closed with caoutchouc. It is shaken briskly for a few moments, returned to an upright position, and allowed to stand for five or six minutes. The oil then collects on the surface. If it is pure olive oil it takes a light ash-grey tint with a slightly yellowish reflection.

Cotton oil, on the contrary, takes a golden yellow at once, and soon becomes of a deep coffee-brown. Mixtures of the two take intermediate shades. The observation must be made about five or six minutes after the oil and acid have been mixed, as on long standing olive oil takes a dark colour.

MEETINGS FOR THE WEEK.

TUESDAY, 13th.—Royal Medical and Chirurgical, 8.30.

Photographic, 8.

WEDNESDAY, 14th.—Microscopical, 8.

THURSDAY, 15th.—Chemical, 8. "Note on the Preparation of Amido- β -Naphthol and β -Naphtho-quinone," by C. E. Groves. "On Hematein and Brazilein," by J. J. Hammett and A. G. Perkins. "Determination of Nitric Acid as Nitric Oxide by means of its Reaction with Ferrous Salts, Part II," by R. Warington.

Philosophical Club, 6.30.

Royal, 4.30.

TO ALKALI MANUFACTURERS.

FOR SALE, a New Filter-Press, by a first-rate maker, suitable for recovery of Magnesian Chloride in the Sulphur Recovery Process of Schaffner and Helbig. Half-price would be taken.—Apply to E. Beanes and Co., Falcon Works, Hackney Wick, London, E.

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Wanted, to Contract for the Purchase of a quantity of Redonda Phosphate.—Address, with particulars and lowest price, "Redonda," care of Chorlton and Knowles, Printers, 6, Oldham Street, Manchester.

RAINHAM, ESSEX, on the banks of the Thames.—To Bone and Chemical Manure Manufacturers, Engineers, Manufacturing Chemists, and others. Valuable Freehold Property, known as Wilson's Chemical Manure and Acid Works, in full work, and eleven cottages for workmen, extending over an area of 2 a. 3 r. 13 p. or thereabouts, together with the costly Plant and Machinery and Goodwill of the Business; also, two plots of Freehold Land, situated near aforesaid Works, together containing 5 a. 3 r. 25 p. or thereabouts, and admirably adapted as sites for the erection of large manufacturing premises; also, two Freehold Ground Rents of £20 per annum each, secured on the Works of the Gas Purification Co., with early reversions to rack rental.

MR. ALFRED SAVILL will SELL the above Freehold Properties (by direction of the Executors) by AUCTION, at the Mart, Tokenhouse Yard, E.C., on Wednesday, the 21st June, 1882, at 2 o'clock precisely, in Five Lots. May be viewed by orders to be obtained at the Auctioneer's Offices, or at Mr. Wilson's Offices, East Ham, E.—Particulars, with plans and conditions of sale, may be obtained of Messrs. Blevitt and Tyler, Solicitors, 794, Gracechurch St., E.C.; at the Mart, Tokenhouse Yard, E.C.; and at the Auctioneer's Offices, 3, St. Helen's Place, E.C.

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THE CHEMICAL NEWS.

VOL. XLV. No. 1177.

ESTIMATION OF ARSENIC IN COPPER.

By A. HUMBOLDT SEXTON,

Lecturer on Chemistry and Physics, Burslem and Tunstall School of Science and Art.

THE estimation of the small quantity of arsenic always present in commercial copper, or the separation of a very small quantity of arsenic from a large amount of copper, is a matter of considerable difficulty, as the ordinary methods of separation fail to give accurate results.

Having had a very extensive experience in the analysis of copper, and knowing the extraordinary discrepancies which occur in analyses of the same sample of copper by different chemists, which can only arise from the use of imperfect methods, I give the results of my experience with the various methods in use, and of a method which I devised and which I have found to give quite accurate results.

1. Separation by sulphuretted hydrogen in an alkaline solution.

It is well known that copper precipitated in this manner carries down with it a portion of the arsenic; indeed in an ordinary B.S. copper the whole of the arsenic is thus taken down. This method is therefore quite fallacious.

2. Abel and Field's method.

Abel and Field in the course of their researches on copper devised a method for the determination of arsenic and antimony, which has since come into general use, almost to the exclusion of all others, the fame of the authors having been sufficient to secure its acceptance. This method is so well known that it need not be described here, a full account of it will be found in *Watts's Dictionary*, vol. 11, p. 61. Suffice it to say that it is based on the precipitation of the arsenic as lead arsenate, by means of lead nitrate and ammonia and ammonium carbonate, the lead arsenate being subsequently decomposed with oxalic acid, the arsenic precipitated as sulphide, and finally weighed as ammonio-magnesium arsenate.

This method, however, notwithstanding its popularity, is not satisfactory, as it gives results always, and sometimes considerably, too low, the arsenic apparently not being completely precipitated in the first instance as lead arsenate.

3. By precipitation as basic arsenate of iron.

If to a solution containing arsenic acid, iron be added and then ammonia in excess, the acid should be thrown down completely, and I hoped that by this means the arsenic could be separated from the copper; but this method gave results far less satisfactory than the preceding. The arsenic was never completely precipitated even in presence of enormous excess of iron, sometimes as much as 10 per cent., rarely less than 3 per cent. of the arsenic remaining in solution.

4. By precipitation as basic arsenate of iron by means of sodium acetate.

After repeated experiments the following method was devised:—

The copper is dissolved in nitric acid, a small quantity of solution of ferric nitrate added, the solution nearly neutralised with sodium hydrate (not ammonia) and excess of sodium acetate added. The solution is then heated to boiling, filtered as rapidly as possible; the precipitate after being well washed is dissolved in hydrochloric acid, the solution made alkaline with ammonia and saturated with sulphuretted hydrogen and filtered from the precipitated

iron sulphide. The filtrate is acidified with hydrochloric acid and let stand in a warm place for some time. The arsenic and antimony sulphides are filtered off, dried at 100° C., the precipitates removed completely from the paper into a small beaker, treated with red fuming nitric acid, a few drops of hydrochloric acid being added as soon as the action has ceased. It is then diluted, filtered, the arsenic precipitated as ammonio-magnesium arsenate, and weighed as usual. If the precipitated sulphides cannot be perfectly removed from the filter paper, the paper must be treated with nitro-hydrochloric acid, filtered, and the filtrate added to the nitric acid solution.

I have found this method to be very accurate, and each stage has been carefully experimented upon. It requires, however, some special precautions.

When the sodium acetate is added the colour of the solution should change from pale blue to dark green; this shows that the solution has been sufficiently neutralised. The beaker must be removed from the heat immediately the solution begins to boil; if the solution be left boiling (sometimes when it is not), a greenish white precipitate of basic acetate of copper falls. This can generally be removed by the addition of a few drops of hydrochloric acid, but in cases where it has separated on the surface of the beaker, or where it will not readily dissolve, it is best to throw out the solution and commence again.

This is very troublesome to those using this method for the first time, but after a little experience has been gained it very rarely happens.

The precipitate should have the dark red colour of ferric acetate; if it is paler it is due either to there not being sufficient iron, or to the co-precipitation of some basic acetate of copper. The filtrate should be blue or pale green; sometimes it is dark green and turbid, from the presence of iron acetate carried through the filter; in that case the first portions must be passed through the filter again.

The precipitate must be washed till it is free from copper, and when it is dissolved in hydrochloric acid the solution must have the yellow colour of ferric chloride. If it is at all green, the solution must be neutralised a little more sodium acetate added, and the iron and arsenic re-precipitated.

I also made a larger number of experiments in order to ascertain the amount of iron necessary for complete precipitation. With equal quantities of iron and arsenic a small quantity of arsenic remained in solution, and the iron arsenic precipitate was of a pale colour. With 1.5 parts of iron to 1 of arsenic the precipitation was complete. In order to make sure it is well to add about twice as much iron as it is expected there is arsenic present. Then even if a little iron remains unprecipitated all the arsenic will be thrown down.

Since copper sulphide retains so much arsenic it might be expected that iron sulphide would act in a similar manner, but it does not; if there be no copper present the precipitate is quite free from arsenic, but if copper is present a considerable quantity of arsenic may be retained. Hence the importance of thoroughly washing the acetate precipitate and re-precipitating it if necessary. The antimony will be in the filtrate from the ammonio-magnesium precipitate, and may be estimated as recommended by Abel and Field, fuming nitric acid being preferable as the oxidising agent.

The arsenic may also be readily estimated by precipitation with ammonium molybdate, re-dissolving in ammonia, and precipitating as ammonio-magnesium arsenate; but in this method the antimony must be estimated in a separate portion, and that can only be done by one of the methods (3 or 4) previously described.

Pharmaceutical Society of Great Britain.—At the meeting of the Council of this Society on the 7th instant, Mr. M. Carteighe was elected President for the ensuing year.

REVISION OF THE ATOMIC WEIGHT OF ALUMINUM.*

By J. W. MALLET, F.R.S.,
Professor of Chemistry in the University of Virginia.

Need for a Re-determination of the Atomic Weight of Aluminum.

THERE is probably no one of the so-called chemical elements equally abundant in nature with aluminum, and occurring in as numerous compounds, with regard to the atomic weight of which our knowledge has long rested upon so slender a foundation of accurate experiment. The following brief statement includes, I believe, all the determinations of this constant which are on record.

Former Determinations.

1. *Experiments of Berzelius, 1812.*—Berzelius precipitated a solution of alum by addition of ammonia, dissolved the precipitate in sulphuric acid to saturation, filtered, concentrated the filtrate by evaporation, and threw down aluminum sulphate by alcohol. This salt was well washed with alcohol, to separate as far as possible any excess of acid, and was then heated in a platinum crucible over an alcohol lamp, weighing from time to time, until no further loss of weight occurred. The anhydrous sulphate so obtained was but slowly soluble in water on heating, but left no insoluble residue. 10 grms. of this salt was now raised to a higher temperature in a weighed platinum crucible, and strongly heated as long as any loss of weight could be detected. The residue of loose, light, white alumina found in the crucible weighed 2.9934 grms. Consequently the salt consisted of—

| | | | |
|--------------------------------------|----|---------|------------|
| " Sulphuric acid " (SO_3) | .. | 70.066 | or 100.000 |
| Alumina | .. | 29.934 | or 42.722 |
| | | 100.000 | or 142.722 |

Several small arithmetical errors have been made in the discussion of this single experiment of Berzelius, upon which for nearly half a century the value assigned to the atomic weight of aluminum may be said to have rested.

In the original paper it is calculated that if 42.722 parts of alumina contain 19.96 parts of oxygen (the atomic weight of sulphur being then taken = 201.16—O = 100), 100 parts of alumina must include 46.736 parts of oxygen. This last number should be 46.7207. In a later paper; by the same author, it is calculated from the results of the above experiment, that 100 parts of "sulphuric acid" are saturated by 42.722 parts of alumina, and that the earth contains 46.7047 per cent. of oxygen; the earth is assumed to be Al_2O_3 , and consequently the atomic weight of Al is found = 171.667 (O = 100), or 27.49 (H = 1). These numbers, correctly calculated from the percentage of oxygen taken in this second paper, should read 171.167 and 27.39 respectively. Or, if the percentage of oxygen of the former paper, corrected as above, be taken as 46.7207, the atomic weight, for Al_2O_3 , will be 171.057 (O = 100) or 27.37 (H = 1).†

Finally, if Berzelius's direct results of experiment be taken, and re-calculated with Stas's atomic weights for O (15.96) and S (31.98), the atomic weight of aluminum, its oxide being assumed Al_2O_3 , will be 27.237 in reference to that of hydrogen as unity.

Berzelius also attempted to obtain a pure hydrate of aluminum by precipitating the sulphate and nitrate with ammonia, but found that highly basic salts only were thrown down. Using the chloride instead, a hydrate was

obtained which, after being dried in the sun, gave only water on heating, but there was a little loss from mechanically-carried over alumina. This sun-dried hydrate left 64.932 per cent. of alumina free from acid. Berzelius therefore calculates that 100 parts of anhydrous alumina had been combined with 54 parts of water—this amount of water containing 47.65 parts of oxygen: while the alumina contains, as shown by the above-quoted analysis of the sulphate, 46.726 parts of oxygen. He remarks: "I cannot affirm that either the determination of the amount of water or that of the oxygen in the alumina is sufficiently exact; both are, however, so far so as to sufficiently show us that alumina, like the preceding bases, combines with an amount of water whose oxygen is equal to that of the earth itself."

In the decomposition by heat of aluminum sulphate, as thus used to furnish data from which to calculate the atomic weight of the metal, the following possible sources of error may be noticed: The hydrate precipitated by ammonia from a solution of (presumably) *basic* alum might carry down with it traces of fixed alkali, and this latter be retained in the sulphate after washings prepared from the hydrate. The tendency of aluminum to form basic salts suggests the possibility of traces of sulphuric acid being lost in the preliminary drying over the simple alcohol lamp, even at a temperature at which possibly the last traces of water might not have been removed. I have found from my own experiments that a trace of basic sulphate may, on the other hand, be obstinately retained even after prolonged exposure to a very high temperature, when it might be assumed that pure alumina alone was left. As Berzelius himself says, ignited alumina rapidly absorbs moisture from the air, involving risk of error in determining its weight. Traces of the light pulverulent alumina are liable to be mechanically carried away during the decomposition of the sulphate. It is observable that all these sources of error, except the last, tend in the same direction, to make the atomic weight of aluminum come out too high.

2. *Experiments of Sir Humphry Davy, 1812.*—In Sir Humphry Davy's "Elements of Chemical Philosophy," published in 1812, the same year in which Berzelius's first paper on this subject appeared—it is stated "that no direct researches had then been made on the quantity of oxygen in alumina, but that, from some experiments by the author on the quantity of ammonia required to decompose saturated solutions of alumina in acids," it would appear that the number representing alumina is about 48, and, supposing it to consist of one proportion of aluminum and one of oxygen, 33 will be the number representing aluminum." The details of the experiments in question are not given, and the combining proportions of all substances having been very imperfectly known at the time—the number 15 is taken above for oxygen—it is needless to say that this passage throws no light upon the exact atomic weight of aluminum.

3. *Experiments of Thomson, 1825.*—Thomson attempted to deduce the number representing this atomic weight from, (a) analyses by himself and others of sundry natural aluminous silicates, (b) analyses of potassium alum, and (c) analyses of hydrates of aluminum. He concluded from all his experiments that the true number for alumina is 2.25 (O = 1), and, taking alumina to be AlO , he made $\text{Al} = 1.25$. This corresponds to $\text{Al} = 30$, if O be assumed = 16, and alumina Al_2O_3 —a result which can only be viewed as a rough approximation to the truth, since Thomson's methods were far from accurate, and his experimental results agree but poorly with each other.

4. *Experiments of Mather, 1835.*—W. Mather, Assistant Professor of Chemistry at the United States Military Academy, West Point, prepared anhydrous alu-

* From the Philosophical Transactions of 1860. Paper read before the Royal Society, April 22, 1860.

† Gilbert's *Annalen der Physik*, 40 (1812), 260.

‡ Poggendorff's *Annalen der Physik u. Chemie*, 8 (1836), 187.

§ A. C. Gudemann, Jr. (in his "Historisch-kritisch Uebersicht von der Bestimmung der Äquivalent-Gewichte von zwei und zwei Metallen"; Leiden, 1853), calculates, from Berzelius's figures, $\text{Al} = 171.02$.

¶ Gilbert's *Annalen*, loc. cit.

* Vol. 4, 263, of the Collected Works of Sir H. Davy, edited by his brother Dr. John Davy, London, 1840.

† Thomas Thomson, M.D., "An Attempt to Establish the First Principles of Chemistry by Experiment," 3, 285; London, 1812.

‡ Sullivan's *American Journal of Science and Arts*, 27 (1835), 241.

minum chloride by Wöhler's process, dissolved a weighed portion of it in water, added silver nitrate in excess, filtered off, dried and weighed the silver chloride formed, threw down excess of silver from the filtrate by hydrochloric acid, filtered again, evaporated this second filtrate and washings to dryness, ignited the residue, and weighed it as alumina. 0.646 grm. of aluminum chloride gave 2.0549731 grms. of silver chloride (yielding on reduction 1.548161 grm. of silver) and 0.2975 grm. of alumina.

From the amount of silver chloride found and silver obtained from it in this one experiment, and from the atomic weights of silver and chlorine adopted by Berzelius and Thomson respectively, Mather calculated values for the atomic weight of aluminum ranging from 1.82274 to 1.85430 ($O = 1$, and the formula of the chloride being taken as $AlCl_3$), or 29.16384 to 29.66880 for $O = 16$; but from the amount of alumina obtained and the amount of aluminum therein (the latter deduced from the chloride taken for analysis minus the chlorine found), he calculated the atomic weight for aluminum as 1.818807 ($O = 1$) for alumina taken as Al_2O_3 , or 21.1008272 for $O = 16$. He does not seem to have been struck by the evidence of some error in his own work which these discrepant numbers afford, but suggested that the figures given by Berzelius for the aluminum and oxygen in alumina might have been accidentally inverted, which would explain the disagreement between himself and the great Swedish chemist. In reality it is pretty plain that Mather's alumina was not pure, either from fixed matter of some kind left behind from the acids and wash water used, or from absorption of moisture before weighing. If his most direct result only be taken as the basis of calculation, namely, the weight of aluminum chloride used and silver chloride obtained from it, using Stas's numbers for chlorine (35.37) and silver (107.66), the atomic weight of aluminum found will be 28.778 for the formula $AlCl_3$.

5. *Experiments of Mallot, 1857.*—In 1857 the writer of this paper attempted to use metallic aluminum, which had not long before begun to be manufactured and sold, for the determination of the atomic weight. At the meeting of the British Association held in that year at Dublin,† he gave a brief account of his experiments, which had been made with the metal of commerce, containing, as he found, only from 93 to 96 per cent of pure aluminum. The exact nature and amount of the foreign substances present, chiefly iron and silicon, having been determined, the crude metal was dissolved in hydrochloric acid, the solution precipitated by ammonia, and from the amount of alumina left from the precipitate on ignition, after allowing for the impurities, the atomic weight was deduced. The results obtained from a few experiments were not satisfactory enough to warrant any proposal to modify the then received number. The probability that this number needed correction, was, however, pointed out, with reasons for such an opinion; the desirability of obtaining for the purpose of new experiments really pure metallic aluminum was noticed; and it was suggested that difficulties connected with the accurate determination of alumina by the method which had just been tried might make it eligible to determine instead the hydrogen given off during the solution of the metal in acid.

(To be continued.)

Determination of Lead Peroxide.—H. Fleck.—The author decomposes the peroxide with hydrochloric acid, conducts the chlorine into a solution of potassium iodide, and titrates the iodine set at liberty.—*Journal de Pharmacie et de Chimie*.

* The seven decimal places are given, notwithstanding the statement by the author himself that his balance could weigh easily 1.0000 grain, and was sensible to 1.000000 grain.

† "Report of British Association Meeting at Dublin, 1857," Transactions of Sections, 23.

ACTION OF INSOLUBLE METALLIC SULPHIDES UPON A SOLUTION OF ACID NICKEL SULPHATE IN PRESENCE OF SULPHURETTED HYDROGEN.

By M. H. BAUBIGNY.

If the progressive formation of nickel sulphide in a solution of the sulphate of this metal containing sulphuretted hydrogen is a function of the relation of the weights of the acid and of the metal present, as I have announced it is, because the precipitated sulphide, *i.e.*, the insoluble body, intervenes in the reaction of the compounds still in solution, it results from this hypothesis that (1) if we take away at any given moment the sulphide existing from the medium formed by the solution of nickel sulphate, the reaction must stop; (2) if to a solution of the acid sulphate of nickel we add a quantity of the sulphide of this metal, such that the weight of the free acid and that of the metal added in the form of sulphide are in the proportions of weight necessary to form a neutral or feebly acid sulphate, the nickel in solution must be progressively precipitated as sulphide.

If from a solution of neutral nickel sulphate (1.100 grm. in 140 c.c. of water), and saturated at 0° with sulphuretted hydrogen we remove after some hours by filtration the sulphide deposited, the solution will not give any further precipitate of sulphide if exposed anew at the ordinary temperature, even if care be taken to re-saturate it at 0° with sulphuretted hydrogen before closing the vessel. This first result was easy to foresee, for we may consider the liquid separated from the sulphide as constituting a new initial state, that of a solution of acid nickel sulphate. It is equally true that nickel sulphide, if placed in a solution of acid sulphate of the same metal, identical to that from which it has been separated by filtration, re-establishes the former conditions. In any case the state of the sulphide employed has its importance. The crystalline and compact sulphide, as obtained under certain conditions, of which hereafter, is inactive, or at least took no effect in the course of fifteen days. Nickel sulphide does not act by its presence, like a porous body, but chemically.

If we substitute for the nickel sulphide zinc sulphide in the same state of division, and operate otherwise under the same conditions, the totality of the nickel sulphide remains in solution even after a month of action. Copper sulphide, on the other hand, acts like nickel sulphide. If to a solution of 0.731 grm. nickel sulphate in 140 c.c. of water we add any given weight of neutral copper sulphate—1.500 grm. for instance—and saturate it with sulphuretted hydrogen gas before closing the vessel, then in spite of the relatively considerable quantity of acid set at liberty from the formation of copper sulphide, there remains in the liquid eight days afterwards merely 0.440 grm. nickel sulphate.

In a solution of neutral sulphates containing merely zinc and nickel sulphuretted hydrogen cannot precipitate nickel sulphide along with the zinc unless the weight of the zinc is much less than that of the nickel—about one-third according to the author's former observations. But it can in any case be prevented by adding a little free acid to the solution.

With copper, on the contrary, nickel may be precipitated whatever may be the proportions of weights of the two metals, nickel and copper, if we operate with neutral sulphates, and this precipitation can be effectually prevented only by the addition of free acid in sufficient quantity. Further, when the precipitation is once begun, it must be conducted rapidly and without interruption, and the first washings in the same manner; for notwithstanding the previous addition of an excess of free acid the conditions of the medium changing constantly during filtration, as well upon the filter as in the beaker, there comes a time when the copper sulphide and the small quantity of liquid which still moistens it are in such proportions in this

medium that the totality of the weights of the two metals, copper and nickel, bears the same proportion to the totality of the acid, free and combined, as in a neutral sulphate, conditions in which the copper sulphide can act upon the nickel sulphide. If these conditions are too much prolonged the analysis becomes necessarily inexact.—*Comptes Rendus*.

ANALYSIS OF INDIAN BREWED AND OTHER ALES.

By C. J. H. WARDEN,
Bengal Medical Staff, Chemical Examiner to Government, &c.

THE following is a tabulated statement of the composition of twelve samples of Indian brewed, and five samples of imported beer. The samples were received from the Commissariat Department in sealed bottles:—

| Place of Manufacture, &c. | Specific Gravity at 15° C. | Proof Spirit by Volume. | Extraction p.c. dried at 100° C. | Malt in lbs. per Gallon. | Total Acidity as (C ₂ H ₃ O ₂) per cent. | Ash per cent. |
|--|----------------------------|-------------------------|----------------------------------|--------------------------|--|---------------|
| Ale. —Dyer and Co., Simla | 1007.91 | 13.87 | 4.75 | 2.491 | 0.192 | 0.240 |
| " East India Pale," Whymper and Co., Mussorie .. | 1011.11 | 12.1 | 5.41 | 2.377 | 0.288 | 0.43 |
| Munee Brewery Co. | 1008.11 | 15.03 | 4.63 | 2.059 | 0.198 | 0.25 |
| " Troops Ale, Nyna tal Brewery Co. | 1011.11 | 11.8 | 5.07 | 2.32 | 0.192 | 0.39 |
| " India Pale Ale," Mackinnon & Co., Mussorie .. | 1010.39 | 12.9 | 4.65 | 2.473 | 0.168 | 0.25 |
| " Canteen issue," Meakin and Co., Kasauli | 1012.43 | 11.2 | 5.39 | 2.293 | 0.144 | 0.21 |
| Porter. —" Canteen issue," Meakin and Co. | 1016.55 | 11.92 | 6.67 | 2.551 | 0.246 | 0.42 |
| Whymper and Co. | 1015.23 | 12.7 | 6.57 | 2.642 | 0.300 | 0.48 |
| Mackinnon and Co. | 1010.91 | 11.6 | 5.52 | 2.314 | 0.336 | 0.35 |
| Nyna tal Brewery Co. | 1010.15 | 10.7 | 4.59 | 2.14 | 0.288 | 0.24 |
| Munee Brewery Co. | 1010.63 | 10.8 | 5.46 | 2.213 | 0.36 | 0.35 |
| Dyer and Co., Simla | 1012.48 | 13.4 | 5.31 | 2.621 | 0.276 | 0.25 |
| " Tivoli Beer" | 1014.13 | 10.2 | 6.44 | 2.198 | 0.228 | 0.27 |
| " Anglo-Bavarian Beer" | 1001.63 | 11.0 | 2.57 | 1.843 | 0.21 | 0.31 |
| " Pilsener Beer" | 1006.07 | 8.3 | 3.19 | 1.563 | 0.12 | 0.06 |
| Imported English Ale (Cash) — | | | | | | |
| Taylor, Walker, and Co. | 1004.39 | 11.0 | 3.25 | 1.970 | 0.306 | 0.27 |
| " " " (Porter) | 1005.75 | 11.92 | 3.67 | 2.117 | 0.288 | 0.14 |

The extractive matter was calculated in weighed quantities of the samples. In determining the amount of malt used per gallon no deduction was made on account of loss of gravity from acetic acid.

Medical College, Calcutta, April 24, 1882.

ON THE DETERMINATION OF CHLORINE IN PRESENCE OF BROMINE AND IODINE.

By G. VORTMANN.

MM. C. L. Müller and G. Kircher have recently published in the *Berichte der Deutschen Chemischen Gesellschaft* certain experiments on the behaviour of peroxides with chlorides, bromides, and iodides in presence of free acetic acid. On the faith of these experiments they maintain that the author's method of separating chlorine from bromine and iodine (*Berichte*, xiii., 325) is not trustworthy. A full description of the process appears in the May number of the Vienna *Monatsschrift*, and in the meantime the author seeks to explain how MM. Müller and Kircher have arrived at results differing so widely from his own. As regards the fact that on boiling potassium chloride, lead peroxide, and acetic acid a perceptible escape of chlorine, and consequently a loss of hydrochloric acid, occurs, his observations agree with those of the chemists

just named, provided the concentration of the acid exceeds 5 per cent. He has observed, however, that not a trace of potassium chloride is decomposed if acetic acid of only 2 to 3 per cent is used, and the evaporation is conducted upon the water-bath, even when the evaporation is repeated five or six times; under which circumstances potassium iodide is easily decomposed and potassium bromide less readily, but still in small quantities, completely if the evaporation is repeated two or three times. The same holds good with the action of manganese peroxide and acetic acid upon potassium bromide. Whilst acetic acid at 2 or 3 per cent decomposes potassium iodide in presence of manganese peroxide very easily the first or second time of evaporation, the same mixture has no action upon potassium bromide, and acetic acid at 10 per cent must be used to liberate even traces of bromine. The author promises to publish the details of analyses showing that his method is not merely accurate but in many cases very convenient.—*Berichte der Deutschen Chemischen Gesellschaft*.

THE MOST CONVENIENT SCALE FOR A THERMOMETER USED IN GAS ANALYSIS.*

By EDWARD W. MORLEY, of Hudson, Ohio.

(ABSTRACT.)

It is impossible to dispense with a thermometer in gas analysis, if accuracy and rapidity of work are both required. No method of keeping the temperature constant, nor of mechanically compensating for its variations, answers this double requirement. My analyses of air are made with a probable error of but the four-hundredth part of one per centum. In them the total reduction of the whole analysis, that is the computing the percentage of oxygen from the readings of scale and thermometer, takes less than two minutes and a half. No system other than that which determines the temperature, and corrects for its variations, can equal this in rapidity.

If the thermometer is to be used in gas analysis, it is worth while to provide it with that form of scale which is most economical of time. Usually it is necessary to read the centigrade degree on its scale, and then consult a table for a logarithmic factor corresponding; the thermometer ought to be so graduated as to show this logarithm directly, dispensing with the table.

A seeming difficulty lies in the fact that the degrees are of varying length, and hence not so easy to produce on a

* Proceedings of the American Association for the Advancement of Science, vol. xxix., Boston Meeting.

graduating engine. But since all that is required is that the graduations shall show logarithms accurate in the fifth decimal place, the difficulty can easily be surmounted. We may compute the places on the centigrade scale at which every third logarithmic degree would end, and then divide these intervals of three logarithmic degrees into thirty tenths at one setting of the engine. No error would appear in the fifth decimal place in this way. As the logarithmic degrees mentioned are two-thirds as long as centigrade degrees, the number of settings of the engine, to reach say thirty-five degrees, would not be too troublesome.

The most convenient method of numbering these logarithmic degrees may be described. The freezing-point should be considered as corresponding to the logarithm of unity; at about sixteenths of a centigrade degree above this point will be a logarithm differing from the former by one-thousandth; the space between this and the former is to be divided into ten equal parts, which represent units of the fourth place of decimals, and read by estimation to units of the fifth place of decimals. This logarithm differing by one-thousandth from the logarithm of unity should be numbered 99, representing the logarithm 0.99900. At about 1.2 centigrade will stand logarithmic degree 98, representing logarithm 0.99800. The scale is continued upwards in this way, the numbers decreasing upwards. The number taken from this scale, followed by the tenths and hundredths, and preceded by the figure nine, supplied mentally, is the logarithm to be added to the logarithms of tension and observed volume to reduce apparent volumes at other temperatures to the freezing-point.

REMARKS ON JOLLY'S APPARATUS FOR DETERMINING THE AMOUNT OF OXYGEN IN AIR.*

By EDWARD W. MORLEY, of Hudson, Ohio.

(ABSTRACT.)

This apparatus resembles Jolly's air-thermometer. The air to be analysed is contained in the bulb of the apparatus, and is measured by determining its tension at the freezing-point. Its oxygen is absorbed by a spiral of copper wire heated by an electric current, and the residual nitrogen is measured at the freezing-point. The process is simple, and the apparatus is simple and economical; but it can claim no greater accuracy than has been obtained by a great many experimenters by means of the more rapid process with eudiometric apparatus.

Let us compare its accuracy with the accuracy of the Bunsen long eudiometer, and that of the Franklin and Ward apparatus. We compute the probable error of Jolly's apparatus on the hypothesis that the probable error of the so-called Jolly point is the hundredth of a millimetre, and that at the other three measurements is the tenth of a millimetre. This probable error of the result may be compared with the probable error computed for the two other apparatus on the hypothesis that the probable error in each reading is the same quantity as that in the corresponding kind of reading in the Jolly apparatus, namely, the tenth of a millimetre.

The error at the Jolly-point is partly one of volume observed, and partly of tension observed. The two have always the same sign, and form but one independent error. The error at the top of the manometric column, and the errors at each end of the barometric column, form the other three independent errors to which the measurement is liable. Their total effect makes the probable error of the measurement 0.023 per centum.

The volume of air taken for analysis enters the result as a denominator and as a minuend in the numerator. These

two effects have contrary signs, and the residual effect is four-fifths of the probable error of the measurement. The probable error of the other measurement of residual nitrogen enters the result with its full value. Their joint effect makes the probable error of the result 0.029 per centum.

Now in the eudiometric process, the error in the measurement of air enters the result only as a divisor, with one-fifth its value. The measurements before and after explosion affect the numerator with one-third their value. All the errors of measurement are diminished threefold and fivefold in their effect on the result. The errors probable in the result with the Bunsen long eudiometer and with the Frankland and Ward apparatus are 0.027 and 0.019 per centum, for a probable error of a tenth of a millimetre in each scale reading. Therefore, while a Jolly apparatus can make more accurate single measurements than the other methods, it is not capable of obtaining so accurate final results.

If the apparatus be modified, as the air thermometer has been modified, by closing the end of the manometer tube, and dispensing with the barometer, the apparatus will give as good results as the Frankland and Ward apparatus. The probable error of a measurement becomes 0.014 per centum, and the probable error of the result 0.019 per centum, both on the hypothesis of a probable error of a tenth of a millimetre in each scale reading and of a hundredth at the Jolly-point.

The following table shows the probable comparative errors of the four apparatus mentioned:—

Probable Errors of Measurements and of Final Results for Probable Errors of one-tenth m.m.; and of one-hundredth m.m. for Jolly-point.

| | Bunsen long eudiometer. | Frankland & Ward apparatus. | Jolly apparatus, unmodified. | Jolly apparatus, modified. |
|-----------------|-------------------------|-----------------------------|------------------------------|----------------------------|
| | P.c. | P.c. | P.c. | P.c. |
| Probable error— | | | | |
| 1st measurement | 0.045 | 0.034 | 0.023 | 0.014 |
| 2nd measurement | 0.059 | 0.042 | 0.023 | 0.014 |
| 3rd measurement | 0.048 | 0.033 | — | — |
| of result . . . | 0.027 | 0.019 | 0.029 | 0.019 |

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, June 10th, 1882.

Prof. CLIFTON, President, in the Chair.

New member—Major-General Martin, R.E.

Mr. W. F. STANLEY read a paper on "*Sonorous Vibrations*," especially those of the tuning-fork. The larger and more visible movements of a sounding body do not appear to be best fitted to propagate musical sounds, as was shown by placing disks on the prongs of a powerful fork, which, when vibrating, could then only be heard a short distance, whereas by its smaller longitudinal motions when placed on its resonator it produced a penetrating sound. The vibration down the stem of the fork was shown not to depend upon a vibrating ventricle, as suggested by Chladni, for a fork cut in the end of a solid steel bar communicated sonorous vibrations equally well to the resonator. To set a fork in vibration it was necessary to bow one prong only; therefore, in this case, the vibration must proceed along the prongs. A light fork, 1 metre long, was fixed in a heavy vice, and it was shown by it that vibrations passed down one prong and up the other alternately. By means of dust, ripples were shown to run down an ordinary fork in vibration. Light pieces of metal were fitted to the ends of a powerful fork and these immersed in mercury, the reflected surface of which was

* Proceedings of the American Association for the Advancement of Science, Vol. xxix., Boston Meeting.

shown on a screen, where it was seen that the whole mercury surface was broken into fine ripples. It was suggested that such small waves are also perceived by the ear. By these, certain conditions of harmonics could be better accounted for, as, for example, by division; in smaller waves the rarefaction of a note in space would not suffer interference by the condensation of its octave falling in the same space and time.

LORD RAYLEIGH explained several of Mr. Stanley's experiments on the known theory of sound.

MR. WALTER BAILY then exhibited a model of a "New Integrating Anemometer." This apparatus contains a horizontal plane, in which are two slits, forming a cross, with arms towards the cardinal points. Each slit is fitted with a sliding piece, and the two slides are connected by a bar, the arrangement being that of the well-known instrument for drawing ellipses. The slides carry beneath them, wheels, with their planes perpendicular to the slits and passing through the pivots of the bar. The wheels rest on a horizontal disk, whose centre is beneath the centre of the cross. The centre of the bar is to be connected to a weathercock, which will keep it in the direction of the wind when looked at from the centre of the instrument. The disk is to be revolved by Robinson's cups. The number of revolutions of the wheels then give the integral of the resolved parts of the wind in the direction of the cardinal points. In the working model of the instrument exhibited there was an electrical arrangement connected with four indicators, one for each of the cardinal points. At each turn of a wheel a circuit was completed, and the corresponding indicator moved. Recording instruments are to be substituted for indicators, and the amount recorded on each in a given time will be proportional to the total motion of the wind towards the corresponding cardinal point.

MR. LECKEY pointed out that a good anemometer was a great desideratum at present.

The Society meets at Oxford on the 17th, and South Kensington on the 24th of this month.

NOTICES OF BOOKS.

Dyeing and Tissue-Printing. By W. CROOKES, F.R.S. (Technological Handbooks. Edited by H. TRUEMAN WOOD, Secretary of the Society of Arts.) London: G. Bell and Sons.

THOSE of our readers who have taken an interest in the City and Guilds of London Institute for the Advancement of Technical Education will be aware that the want of a series of manuals specially adapted for the use of students preparing for the examinations of the Institute soon made itself felt. On the tinctorial arts, for instance, there certainly existed important and valuable treatises. But they were for the most part too costly for students, many of whom would probably be of limited means. Other works, again, were unsuitable because they did not begin at the alphabet of the arts in question. What was needed, therefore, was a handbook, not too costly, plain, and simple in its style, covering the whole ground, and making no special demands upon the previous knowledge of the student. Mr. Crookes has undertaken the somewhat difficult task of drawing up such a work, and appears to have succeeded in fulfilling the various conditions above laid down. The only previous qualification of which the student is assumed to be possessed is an elementary knowledge of chemistry, such as may be acquired from almost any of the rudimentary treatises on that science. The author, building upon this foundation, seeks to explain the principles of the art from a practical rather than from a theoretical point of view. From the very outset he endeavours to explain everything with which the learner might be puzzled. In the preface there are

given explanations of certain measures used in dye-works, &c., and little known elsewhere. In the "General Introduction" the first point brought forward is the cleansing of the goods to be operated upon—a matter in which even experienced dyers are often sadly indifferent, and thus insure an unsuspected source of blunders, which are charged against the dye-works or the mordants, and which can often be rectified only by the expenditure of much time and trouble. Mr. Crookes even demands, as far as is humanly possible, chemical purity in the vessels used, in the materials to be dyed, in the water, and in the dye-works. We know that good results are often produced without the observance of these conditions, but we know also that a prudent man will, if possible, avoid the risk. Half the skill employed in "cobbling" pieces which have come up spotty, or flat, or smeary, would have prevented these evils, and given a far better result.

At this part of the treatise a description is given of the procedures for bleaching the different textile fibres, that is, freeing them from their natural colouring-matters, which in many cases if left remain would be as fatal as artificial dirt.

The next section, on the selection of water for dye- and print-works, has been evidently written with great care. The author points out what kinds of water are needed, from what geological formations it may best be obtained, and what possible ingredients are to be especially avoided. It may here be remarked that the water needed for tinctorial purposes, and, indeed, for the industrial arts generally, is not the same quality as that which sanitary reformers demand for domestic purposes. For dietetic purposes the presence of salts of lime, and even of magnesia and iron, to a moderate extent, is not objected to. For the dyer or the printer, iron is fatal, and compounds of calcium and magnesium greatly interfere with many of his operations. Processes are given for the detection of the ordinary impurities, and for their removal, when necessary, upon the large scale.

Next follows a chapter on mordants. Here the author enters a little more into theoretical considerations than in most parts of the work. He shows that if the addition of the metallic mordants and the nature of the aniline colours had been better understood, practical men might have been saved the trouble of tedious attempts to fasten, e.g., magenta upon cotton fibre by means of aluminium acetate or sulphate. Surely, even those who talk most loudly of the uselessness of what they are pleased to brand as mere "book-knowledge," might see the necessity of having some acquaintance with the properties of the agents they use. To argue that because magenta is a red colour it must be capable of fixation in the same manner as cochineal is not, after all, a very practical procedure. The instructions for the preparation of a nitrate of iron rank among the fullest which have ever been printed, and speak of close and extensive observation.

The accounts of the astringents, of the fatty and the animal mordants—commonly so-called—are exceedingly thorough going.

In the "General Instructions on Dyeing" we find not a little matter which it is probable has never appeared in print before, having probably been overlooked as too elementary. Among other needful matter we find here the introduction of certain technical terms, which would greatly perplex the tyro on his introduction to practical work. Here, also, are plain directions for "matching off" colours, i.e., for comparing the goods dyed with the pattern sent as a standard.

After these general and introductory considerations, follow a series of receipts for obtaining different colours upon cotton. It has evidently been the author's object to exemplify the methods required for dealing with cotton in its different states, such as cotton-wool, yarns, piece-goods of various kinds, such as calico, cotton-velvets, cords, &c., and to show the processes for applying the new colours.

After, cotton, linen, jute, wool, and silk, are worked

through in a similar style, the characteristic features of each staple being noticed in a few preliminary remarks.

The latter half of the book is devoted to tissue-printing in its various styles and branches. It cannot be denied that the work would have been more useful had it been illustrated with dyed and printed patterns, diagrams of machinery, &c. But such additions would have involved such an increase in the price of the book as to be out of the question. For the purpose in view this treatise will form a sound and useful basis for the student.

The Laboratory Guide, a Manual of Practical Chemistry for Colleges and Schools, specially arranged for Agricultural Students. By ARTHUR HERBERT CHURCH, M.A., of Lincoln College, Oxford, Professor of Chemistry in the Royal Academy of Arts, London. Fifth edition, revised and enlarged. London: John Van Voorst.

ON comparing the present edition of Prof. Church's Laboratory Guide with its earlier phases, we cannot fail to be struck with the great changes which have been made. Whilst the general plan of the work has been retained, and whilst none of the features which won for it the general approval of teachers and students have been sacrificed, additions and improvements have been numerous. As instances, the reader may compare the instructions here given for the determination of nitrogen with those laid down, say, in the second edition. Not only is the space devoted to this important process doubled—the precaution of adding an excess of pure dry starch to such substances as hair, wool, and albumen, is recommended, and Ruffe's thiosulphate process is fully described and recommended for the substances which do not yield the whole of their nitrogen as ammonia when burnt with soda-lime in the ordinary manner.

The chapter on the analysis of drinking-water has also been greatly enlarged and modified. It is very satisfactory that Prof. Church does not consider that the character of a water can be deduced from two or three data alone, but considers it advisable to ascertain the presence or absence of phosphoric acid, to observe the action of the water on lead, to apply Heisch's sugar-test, and to submit the deposit to microscopic examination. He does not refer to the presence or absence of free oxygen, which is in some cases an important feature.

The instructions for the determination of the albumenoids in articles of diet, form an exceedingly useful addition in the present volume as compared with the earlier editions. Until a comparatively short time ago it was believed that the nutritive value of any root, leaf, &c., could be discovered by a simple determination of its total nitrogen. It is now known that nitrogen can and does exist in forms in which it is not capable of assimilation by the animal system. Hence a determination of the albumenoids becomes necessary. Two methods for this purpose with carbolic acid and with copper hydrate are accordingly given.

Prof. Church's work as it stands is undoubtedly the best laboratory guide which can be put into the hands of the agricultural student,—a class whose requirements extend far beyond that mere valuation of manures and soils of which they are popularly supposed to consist.

The Pharmacopœia of the London Hospital: Compiled under the Direction of a Committee appointed by the London Hospital Medical Council. London: J. and A. Churchill.

THERE is but little matter in this Pharmacopœia which can fitly fall within the cognizance of the CHEMICAL NEWS. There is in the first place a list of the medical and surgical staff of the Hospital. Then follows the materia medica, in which we merely notice a case where pharmaceutical nomenclature differs somewhat perplexingly from

that of pure chemistry, i.e., calx chlorata, which from the context must evidently mean calcium hypochlorite, but which might easily be understood as calcium chlorate. The formulae for adults and for children call likewise for no remarks from our point of view.

In the instructions for case-taking in the children's ward we note with interest that the Clinical Clerk is required to record whether the patient has been fed upon farinaceous foods. But for the Libel Laws, which may be truly called the quack's shield, these preparations and at least nine-tenths of the so-called patent medicines would have long been swept out of existence.

Next follows a figure and description of Dr. Dupré's apparatus for the determination of urea by the sodium hypobromite process, an account of the determination of sugar in urine by Fehling's process, and a list of solutions for preserving and staining animal preparations.

Then follows a chapter on poisons and their antidotes. It is remarkable that the compounds of chromium are omitted, since, from their extensive use in the arts, they may be accidentally introduced into articles of food or drink. The rest of the book is taken up with a list of the abbreviations used in prescribing, metric weights and measures with their equivalents in the weights and measures of the British pharmacopœia, and tables of doses.

Household Chemistry for the Non-chemical. By A. J. SHILTON, F.C.S. London: F. V. White and Co.

THIS is a work which strongly reminds us of the late Professor Johnston's "Chemistry of Common Life." The writer, indeed, admits in his preface that many books have been written on the chemistry of things commonly met with in daily life, but contends that they have been at fault "in at least one particular," i.e., in containing a quantity of matter "not of a strictly chemical nature, and which, however interesting in itself, swells the book to a large size without adding to its usefulness." It might perhaps here be remarked that matter not strictly chemical may yet be very useful, and may be legitimately introduced into works of a popular class. Indeed, in describing, as the author proposes to do, "certain chemical principles and processes involved in some household operations," it will not always be found easy to eliminate physical and physiological considerations.

Mr. Shilton devotes his first chapter to "chemical preliminaries." In the second he treats of washing soda, common salt, and other sodium compounds, and describes briefly the alkali manufacture. The manufactures of soap and of candles are next sketched. As regards the latter subject it may be asked whether, as the processes of candle-making are mainly mechanical, the author is not, like his predecessors, introducing matter which is "not of a strictly chemical nature."

Ozone, though it figures as an item on the cover of the book, is but slightly noticed in the text. We are glad to find that the author shows himself sceptical as to the alleged wonderful powers ascribed to this compound. He is even hard-hearted enough to inform the British public that the peculiar odour which they greedily inhale at the seaside and regard as a panacea consists principally of the effluvium of "decomposing crabs and seaweed." As regards the proportion of carbonic acid in the air, the chief weight is still laid, as in older manuals, upon its production by the respiration of animals and by combustion, and on its decomposition in the nutrition of plants. But we find no mention of a pair of processes which are at work on a probably larger scale, i.e., on the one hand the exhalation of carbonic acid from volcanoes, and on the other, its withdrawal from the atmosphere in the form of calcium carbonate by certain processes of marine animal life, especially by the coral-worms.

The chapter on water contains some very sound advice, and we are glad to perceive that the author gives his vote for soft water as the more suitable for domestic purposes.

The cost of softening a hard water by dint of soap is given as £47 1s. 8d., as against 8d. for doing the same work by Clark's process. A section on disinfectants, though correct in its statements, does little more than show how very limited as yet is man's power of dealing with disease germs.

Succeeding chapters deal with starch, the sugars, the manufacture of bread, though without any reference to the ultra-filthiness of our modern town bakeries, fermentation, distilling, wines, where the "plastering" fraud is duly denounced, vinegar, the infused beverages, the glass and porcelain manufactures, and the chemistry of food. As the entire compass of the book falls short of 200 pages, not very closely printed, it need scarcely be said that these subjects can be but briefly dealt with. The author, however, may fairly be said to have made the best of his narrow space, and to have given a clear summary of his subjects.

Smithsonian Miscellaneous Collections, 441. *The Constants of Nature. Part V. A Re-calculation of the Atomic Weights.* By FRANK WIGGLESWORTH CLARKE, S.B., Professor of Chemistry and Physics in the University of Cincinnati. Washington: Smithsonian Institution.

INQUIRIES concerning the atomic weights are of the highest importance. Until their values are determined in a manner which excludes all appreciable error, the fundamental questions as to their nature, their possible origin, and their decomposability cannot even be discussed in a fruitful spirit. Great gratitude is therefore due to Prof. Clarke for the systematic re-calculation which he has here undertaken. His object has been to bring together all existing trustworthy data, to reduce them to common standards, and to determine the probable error for each series of figures. By so doing he has cleared the ground for future experimenters, who can now clearly see what remains to be done, and has thrown a light on the relative values of different lines of research. He complains, and with full reason, that in many series of determinations of the atomic weights of elements, it has been neglected to reduce the weightings to a vacuum standard. Errors have thus been introduced; slight and possibly capable of being in many cases safely neglected, but in other instances serious. As another vitiating feature in many otherwise admirably conducted determinations, the author, following Dumas, points to the occlusion of oxygen by silver.

Passing to the various elements he finds from a discussion of the results of Erdmann and Marchand, Dumas, Boussingault, and Regnault, the mean atomic weight of oxygen = 15.9633, with a probable error of ± 0.0035 .

The atomic weights of the group silver, potassium, sodium, chlorine, bromine, iodine, and sulphur are so closely dependent upon each other that they can scarcely be considered separately. The author finds the general mean results (O = 15.9633) as Ag, 107.675; Cl, 35.370; Br, 79.768; I, 126.557; Na, 22.998; K, 39.019, and S = 31.984. If these values are re-calculated on the basis O = 16, they differ from the results of Stas, by fractions of which two only affect the second decimal place. As Prof. Clarke observes, "no other criticism could more severely test the character of Stas' work, or more definitely illustrate his magnificent accuracy."

In the appendix the author examines the bearings of the most recent determinations upon Prout's law. It is very significant that in the silver group of which we have just been speaking the "Dumas correction," i.e., consideration of the oxygen occluded by silver, tells in favour of Prout's hypothesis in five out of the seven cases, leaving one value unaffected and rendering one only less in harmony with the demands of the hypothesis. The question is naturally raised: Have we here in the case of silver an exceptional phenomenon, or do other metals used in the determination of atomic weights occlude, possibly, gaseous impurities. The author refers again to

general sources of error. Thus, if oxygen = 16 instead of 15.9633, the atomic weight of uranium is affected to the extent of 0.548. The atomic weight of carbon depends upon that of oxygen; that of calcium upon carbon and oxygen; that of fluorine upon calcium, carbon, and oxygen as well as upon sulphur, silver, and chlorine.

The author quotes Prof. Mallet's argument in favour of Prout's hypothesis. Taking the atomic weights of eighteen elements, which seem well determined, he shows that ten of them have values which approach whole numbers within 1:10th of a unit. He then asks, what is the mathematical probability that this close approximation to Prout's law in ten cases out of eighteen is purely accidental, as those chemists who reject the hypothesis seem to hold? Working this problem out, Mallet finds the probability in favour of mere coincidence to be in the ratio of 1:109781! In summing up, Prof. Clarke, who entered upon his re-calculation with an admitted prejudice against Prout's hypothesis, considers it more probable that the few apparent exceptions are due to constant errors not yet detected than that the great number of close agreements should be purely accidental. To say the very least the hypothesis of Prout cannot be summarily laid aside as refuted. All truly philosophical chemists who wish to lay a secure foundation for their theories cannot fail to set high store upon Prof. Clarke's treatise.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 21, May 22, 1882.

Absorption of Gases by Platinum.—M. Berthelot. —The study of electrolytic polarisation has led the author to investigate the heat disengaged in the absorption of gases by platinum, especially as regards hydrogen and oxygen. He has operated with platinum in various forms, inclosed in small glass globes holding about 75 c.c. fitted with taps, and containing from 50 to 120 grms. of metal. They were placed in a calorimeter, the globes were exhausted, weighed, and the gas was then admitted so as to saturate the platinum at a pressure as near as possible to that of the atmosphere. On weighing again the increase of weight gives the gas absorbed. When this is done the gas is withdrawn by means of the mercurial pump, at first in the cold, and then at 200°, measuring each time the gas, and noting the losses of weight consecutive on its extrusion. This is then completed by collecting the gases set at liberty, and heating the metal in a tube of hard glass until the glass begins to melt,—an indispensable counter-proof, without which there is sometimes danger of attributing to a hydride the absorption of oxygen, due in reality to the reduction of a platinumous oxide, or to regard as due to some particular state of the platinum an absorption of oxygen, which is in reality due to the oxidation of a hydride. Such hydrides and sub-oxides seem to have been often confounded with platinum itself in the study of the substances called platinum-black. The author finds evidence of two distinct platinum hydrides, the one dissociable and capable of being oxidised in the cold by oxygen, and the other more stable, but capable of being destroyed by the action of heat. All the specimens of platinum-black which the author has been able to procure contained considerable proportions of oxygen, and were sub-oxides. They absorb large proportions of hydrogen, one part of which reduces the oxide, whilst another part forms a hydride. Platinum, in whatever state, if placed in a vacuum and then exposed to oxygen, becomes heated distinctly. The ignition of a

mixture of hydrogen and oxygen by platinum is occasioned by the formation of the less stable hydride and its oxidation in the cold by oxygen.

Action of Oxygenated Water upon Organic Matters and Fermentations.—Paul Bert and P. Regnard.—Oxygenated water in a very dilute state arrests the fermentations due to the development of living beings, and the putrefaction of all substances which do not decompose it. It has no action upon the diastatic ferments. Dilute oxygenated water is destroyed neither by the fats, the amylaceous matters, the soluble ferments, by egg albumen, casein, the peptones, creatine, creatinine, nor urea. It is rapidly destroyed by collagenous nitrogenous matters, muscine, blood-fibrine, and various nitrogenous vegetable matters. This action is completely arrested by a temperature higher than 70°, but is not affected by putrefaction.

Measurement of the Carbonic Acid contained in the Atmosphere.—M. Mascart.—The author considers that specimens of 500 c.c. of air are sufficient for the determination of carbonic acid.

Quantity of Carbonic Acid contained in the Air at Calvès, near Nyon, at the height of 420 metres.—M. Riiser.—The general mean of the monthly determinations from August, 1872, to July, 1873, is 3.035 volumes per 10,000.

Chemical Work produced by the Battery.—D. Tommasi.—Joule and Favre have shown that the power of the galvanic battery is intimately related with the heat produced by the chemical reactions in the battery itself, and that an entire order of questions relative to currents may be treated like problems in calorimetry. Thus the electromotive force of a battery would be proportionate to the heat liberated by the chemical action, and consequently knowing the calories liberated by this chemical action we may find the work which the battery is capable of producing. Favre has shown, however, that the heat brought into play during the combustion of the hydrogen in electrolysis is transmissible or not transmissible to the circuit according to the nature of the compound which furnishes the oxygen necessary for the combustion. Thus, of 131 cal. disengaged by a couple with oxygenated water and hydrochloric acid, there would be merely 41.6 cal. transmissible to the circuit, and representing consequently the energy of the battery. Favre has further observed that in the sublimation of the zinc of a simple couple (zinc, platinum, and acidulated water), 39 cal. are brought into play, but that of this number only 29.8 cal. are transmissible to the circuit, whilst 9 cal. are confined to the interior of the battery. A zinc-platinum element with dilute sulphuric acid (Smee's) should disengage, according to Favre, 39 cal., but of this number only 29.8 would be transmitted to the circuit, and represent the energy of the battery. Two such elements, therefore, ought not to decompose water. 29.8 cal. + 29.8 cal. < 69 cal. But the author has found that the decomposition takes place as if all the calories disengaged by the two elements had been transmitted to the circuit. 39 cal. + 39 cal. > 69 cal. (Favre), or, calculated according to thermic data, 38 cal. + 38 cal. + 1 cal. > 69 cal. If the water of the voltameter is acidulated with hydrochloric acid the decomposition of the water takes place more easily. But even in this case there ought to be no electrolysis, since, according to Favre, 29.8 cal. + 29.8 cal. < 66 cal. If we substitute in the above elements for the two platinum plates two graphites, previously heated to redness—which, according to received ideas, should not in any way modify the chemical action of the battery—the decomposition is produced very briskly. If we employ in the battery electrodes of coke with a large surface, the decomposition of the water is much more energetic. According to Favre two zinc-platinum elements in dilute hydrochloric acid ought not to decompose water if it is acidulated with sulphuric acid, but should decompose it if acidulated with hydrochloric

acid. Two zinc-graphite or zinc-coke elements decompose water acidulated with sulphuric acid. This decomposition cannot be explained according to Favre, but it is intelligible according to thermic data: 34.2 cal. + 34.2 cal. + 1 cal. > 69 cal. A zinc-platinum element in dilute hydrobromic acid ought, according to Favre, to liberate 35.9 cal., but only 29.9 cal. would be transmitted to the circuit. Two of these elements, therefore, ought not to decompose water acidified either with sulphuric or hydrochloric acid, for in the former case 29.9 cal. + 29.9 cal. < 69 cal., and in the second 29.9 cal. + 29.9 cal. < 66 cal. If the water of the voltameter is acidulated with sulphuric acid, decomposition sets in, but ceases soon. The decomposition of the water is more marked with two zinc-coke elements. If the water of the voltameter is acidulated with hydrochloric acid, the decomposition takes place more easily. If the water of the voltameter is acidified with hydrobromic acid, there is also electrolysis, but in this case it is not the water which is decomposed, but the hydrobromic acid itself. However this acid is diluted, gas always escapes at the negative electrode, but at the positive electrode there is no escape of gas, but there appears around the platinum wire a yellow thread of bromine. This fact is easily explained, since 2 mols. hydrobromic acid absorb 59 cal. for decomposition, whilst 1 mol. water absorbs 69 cal., and, as the author has shown in 1879, the compound which absorbs the least calories is always decomposed in preference by the current.

Use of Revolving Discs for the Study of Colour-Sensations. Relative Intensity of Colours.—A. Rosenstiehl.—This paper requires the accompanying diagram.

Hydrosulphate of Nickel Sulphide.—H. Baubigny.—See p. 249.

Action of Alkaline Sulphides upon Stannous Sulphide.—A. Ditté.—If potassium mono-sulphide is caused to act upon stannous sulphide with access of air, the alkaline liquid, even if dilute, dissolves a little of the metallic sulphide, but by the action of the oxygen, which transforms it into a bisulphide soluble in the potassium sulphide, there is produced at the same time a little potassa. The reaction continues thus very slowly, as the liquid obtains oxygen from the atmosphere. If the primitive liquid is sufficiently concentrated, the metallic proto-sulphide is decomposed with formation of sulpho-stannate and of metallic tin; as for the potassa formed under the influence of the air, it is too small in quantity to act in presence of the excess of potassium sulphide.

Researches on the Cuproso-cupric Sulphites.—A. Etard.—The author describes a yellow salt, which might be named an octo-sulphite of cuprosium, cupricum, and sodium, and which if treated with sulphurous acid passes into Chereul's salt, $\text{SO}_4\text{Cu}_2\text{SO}_3\text{Cu}_2\text{H}_2\text{O}$. The yellow salt is prepared by shaking up anhydrous copper sulphate, pulverised in an open flask with a solution of sodium bisulphite at sp. gr. 1.26. If the yellow salt is treated in the cold and with contact of air with sodium bisulphite, there is formed a deep reddish brown salt in spherical agglomerations, $\text{S}_2\text{O}_3\text{Cu}_2\text{Na}_2 + 9\text{H}_2\text{O}$.

Basic Salts of Manganous Oxide.—A. Gorgeu.—A description of a sub-sulphate, sub-nitrate, and oxy-chloride.

Addition of Hypochlorous Acid to Mono-chlorated Allyl-chloride.—L. Henry.—The reaction gives rise to two distinct products: symmetric bichlorated acetone and allene-tetra-chloride.

Bulletin de la Société Chimique de Paris,
Tome 37, No. 8, 1882.

Oxidation-Products of Charcoal obtained by Electrolysis.—A. Millot.—The author refers to the researches of M.M. Bartoli and Papasogli (*Comptes Rendus*, No. 20, 1882), and to similar investigations of his own (vol. xxxiii., p. 262).

Electrolytic Determination of Zinc in Ores.—A. Millot.—Various procedures have been suggested for the electrolytic determination of zinc. An acetic solution has been employed, or by preference a sulphuric, with the addition of ammonium sulphate. The deposit obtained is very adhesive, but the last traces of copper are very hard to separate. M. Beilstein recommends for the determination of zinc in brass, after separating the copper in a nitric solution, the precipitation of the solution by potassa, and the re-dissolution of the precipitate by potassium cyanide. This method occasions the platinum of the electrodes to be attacked, and the formation of a black deposit of finely-divided platinum upon the negative pole. The author has previously proposed the use in this determination of an excess of caustic potash, which gives a very adhesive deposit of zinc, similar to that obtained with cyanide. With pure potassa, entirely free from chlorides, the platinum electrodes are not attacked. The following process gives the best result with ores of zinc: Dissolve 2.5 grms. of the ore in 50 c.c. hydrochloric acid, adding whilst boiling a little potassium chlorate to precipitate the iron. If much silica is present the solution is evaporated to dryness with a little hydrochloric acid. The liquid, when cold and diluted, is mixed with 100 c.c. of ammonia and 5 c.c. of a saturated solution of ammonium carbonate to precipitate the lead and the lime. When cold it is diluted to a half litre and filtered. We take 100 c.c. of the filtrate, corresponding to 13 grm. of the ore, and containing from 0.2 to 0.3 grm. of zinc. There is added 1 grm. pure potassium cyanide, and the whole is placed in a precipitating glass. As a positive pole a cylinder of platinum wire gauze is used, and for a negative pole we place in the interior of the cylinder a platinum cone of the apparatus of M. Riche. The distance between the cone and the gauze ought to be a few millimetres. A current is passed through the solution answering to two Bunsen elements, or that of a Clamond's thermo-electric pile of 150 elements. If the liquid contains 0.25 grm. of zinc there are precipitated in the first hour 0.15 grm., in the second hour 0.075 grm. The last portions of the metal are more difficult to separate, but in nine or ten hours the precipitation is complete. The deposit is very adhesive; it is washed in alcohol, then in water, and the cone is dried and weighed. The zinc is then dissolved off in hydrochloric acid, and the cone is dried and weighed anew. If the ore contains copper, it is deposited with the zinc. The deposit is re-dissolved in nitric acid, and the copper is precipitated by electrolysis in an acid liquid. Cadmium alone is determined along with the zinc, which is the case also in volumetric determinations. When it is present in the ore in notable proportions it must be removed by means of sulphuretted hydrogen. The quantity of potassium cyanide must be exactly limited. If more is used than the weight given the metal will be deposited more slowly, and if the quantity is less the deposit is not adherent. This electrolysis in alkaline liquids occasions an attack of the platinum electrodes, and the formation at the negative pole of a black coating of finely-divided platinum, which is not removed by treatment with acids, but which changes continually the weight of the cone. The author avoids this inconvenience, due to the decomposition of ammonium hydrochlorate and the formation of nascent chlorine, by adding to the liquid to be electrolysed 5 c.c. of a saturated solution of ammonium acetate. The acetate is decomposed by the current, and no chlorine is formed, so that the electrodes are not attacked. Ammonium nitrate answers the same purpose, but it delays the precipitation of the zinc. The results obtained in the absence of cadmium are absolutely exact.

Russian Chemical Society.—Session April 2/14, 1882.—M. Teploff continues his studies on the structure of molecules.

M. Beilstein and Kourbatoff presented their results on the composition of the crude petroleum distilled in the works of Siemens and Halske. It consists chiefly of

saturated hydrocarbons, but it contains also a small quantity of aromatic hydrocarbons.

M. Lubavine pointed out a method of preparing glyoxal by the action of nitric acid upon aldehyd.

M. Werigo called to mind that as far back as 1879, experiments on the oxidation of glycerin were being conducted in the laboratory of the University of Odessa.

M. Przybytek completed his communication (referred to by M. Werigo) on the products of the oxidation of glycerin by means of nitric acid at common temperatures.

M. Wilm, in pursuing his researches on the platinum metals, arrived at the following conclusions: The metals of this group, and especially palladium and rhodium, when they have been precipitated by iron, zinc, hydrogen, or sodium formate, dissolve with remarkable ease in hydrochloric acid in presence of air. Pure rhodium absorbs hydrogen with much greater energy than palladium. The platinum metals cannot be separated from the base metals, such as copper or lead, by means of reducing agents, as they carry down a certain quantity of these metals.

M. Stcherbakoff sent in a paper on the action of normal butyryl chloride upon normal zinc propyl. M. Stcherbakoff also gave a communication on the preparation and properties of zinc propyl.

A memoir was read from MM. Markownikoff and Kabloukoff on a hexylic glycerin, and one from M. Markownikoff on the molecular transformation of tin.

Revue des Industries et des Sciences Chimiques et Agricoles. No. 53, 1882.

Determination of Salicylic Acid in Alimentary Substances.—MM. Pellet and De Grobert.—A voluminous memoir, in which the authors describe the determination of salicylic acid in butter, milk, and urine. The process is volumetric, and the authors make use of a colorimetric of ferric chloride at 1.005 to 1.008 sp. gr., containing 0.5 grm. acid in 100 c.c. They take 25 grms. butter, place it in a cylinder graduated at 200 c.c., add 5 or 6 drops of sulphuric acid at 30° B., and a certain volume of benzol, e.g., 75 c.c., and shake strongly. All the fatty substance is dissolved, and a whitish matter remains in suspension. The total volume is noted, and is made up to exactly 100, 110, or 120 c.c. The solution is filtered; 5 or 10 c.c. of it are taken, and placed in a test-tube of the same diameter as the tubes of the colorimeter; 5 or 10 c.c. of water are added, and 2 or 3 drops of the ferric chloride above mentioned. The tube is shaken repeatedly, but gently, to prevent an emulsion, and when the tint of the lower liquid no longer deepens, it is compared with a standard tube. For greater exactitude the comparison is made not with a tube containing merely water, but with a tube in which is a solution of benzol having dissolved 25 grms. of butter free from salicylic acid per 100 c.c. We place 10 c.c. of this normal solution of butter free from salicylic acid in a test-tube; then 0.2 c.c. or 0.1 c.c. of a solution of salicylic acid at 1 grm. per litre, and 9.8 c.c. or 9.9 c.c. of distilled water; then, lastly, 2 drops of the ferric chloride, and agitate. The proportion of salicylic acid is judged by the comparative colour.

Manufacture of Borax from Boracic Acid.—M. Donnay.—An account of the production of borax from the lagoons of Castel, Nuovo, Tuscany.

Disinfection of Alcohols by Electrolysis.—MM. Naudin and Schneider.—Already noticed.

No. 54, 1882.

Disinfection and Agricultural Utilisation of Blood.—P. Marguerite-Delacharlonny.—The author gives the proportion of nitrogen in dried blood as 12.15 to 18.73 per cent, and the phosphoric acid at 1.63 to 2 per cent. The value of the blood of the 43 million animals yearly slaughtered in France he estimates at 21 million francs. The author describes various methods proposed for

treating blood so as to prevent nuisance. A mixture recommended for this purpose by the Conseil d'Hygiène de la Seine is as follows:—

| | |
|-------------------------|-------------|
| Sodium sulphate | 0'60 kilos. |
| Crude phenol | 0'15 " |
| Common vinegar | 0'15 " |
| Sulphuric acid | 0'025 " |
| Water | 2'500 " |

3'425 "

This quantity is to serve for 100 litres of blood.

Note on Apparatus employed in Determining the Dry Extract furnished by Various Industrial Products.—Armand Le Docte.—This paper cannot be intelligibly reproduced without the two accompanying figures.

Disinfection of Alcohols by Electrolysis.—MM. Naudin and Schneider.—Continued from the last number.

Purification of Waste-Waters from Manufactories.—MM. Gaillot and Hunt.—In this preliminary paper the authors decide that irrigation must in the majority of cases be rejected. Where it is not impracticable it is dangerous.

Cosmos Les Mondes.

No. 3, May 20, 1882.

Mutual Attraction of Ores.—Prof. Doelter.—The author, when experimenting upon various ores with electro-magnets, remarks that the quantity of iron present does not determine the degree of attraction of ores. The sulphides and sulphates which contain much iron are little attracted, whilst the attraction of the oxides, carbonates, and silicates, is very strong. This variation in the quantity of attraction may be useful in the mechanical separation of natural mixtures of ores.

MEETINGS FOR THE WEEK.

WEDNESDAY, 21st.—Meteorological, 7.
Geological, 8.

THURSDAY, 22nd.—Royal Society Club, 6.30. (Anniversary).

FRIDAY, 23rd.—Quekett Microscopical Club, 8.

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THE CHEMICAL NEWS.

VOL. XLV. No. 1178.

NOTE ON β -NAPHTHAQUINONE.*

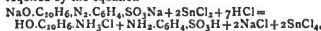
By CHARLES E. GROVES.

IN a paper by Liebermann, published last year in the *Berichte* (xlv., 1310), as also in a more recent communication to the *Annalen* (ccxi., 51), he recommends β -naphthol orange as the most convenient source from which to prepare β -naphthaquinone. Knowing the ease with which β -naphthol can be converted into amido- β -naphthol, this statement seemed to me so extraordinary that I was induced to investigate the reaction.

Liebermann recommends that β -naphthol orange, the sodium salt of β -naphthol-diazo-benzene sulphonic acid, $C_{10}H_6(OH).N_2.C_6H_4.SO_3H$, should be treated with stannous chloride and hydrochloric acid in quantity sufficient to produce the double tin salt of amido- β -naphthol hydrochloride. This occurs in the product mixed with sulphanic acid from which the amido- β -naphthol is separated by treatment with hydrogen sulphide to remove the tin, then decomposing with sodium carbonate, and agitating with ether, of which large quantities are required, as the base is but sparingly soluble in it. On mixing the solution of the sulphate of the base with an oxidising chromic mixture in the manner described by Stenhouse and myself, the β -naphthaquinone is precipitated.

I carefully repeated these experiments of Liebermann, and can fully corroborate his statements as to the results, but not as to the value of the process as a method for preparing β -naphthaquinone. The decomposition of the tin double salt by hydrogen sulphide, involving as it does the precipitation of such a large amount of tin, and the extraction with ether are troublesome and tedious, and the unavoidable loss of ether is considerable. If, on the other hand, we attempt to prepare the β -naphthaquinone from the solution without first separating the sulphanic acid (whether the tin be precipitated by hydrogen sulphide or by metallic zinc), the product is not satisfactory either in quantity or quality.

It was evident that, in order to render the process practicable, the treatment with hydrogen sulphide must be avoided, and a more convenient method of separating the amido- β -naphthol from the sulphanic acid must be devised. A few preliminary experiments showed that these difficulties could be easily overcome. If, instead of employing the large quantity of stannous chloride recommended by Liebermann, but little more is taken than that required by the equation—



the azo-compound is completely decomposed, and the amido- β -naphthol crystallises out *not as double tin salt*, but as hydrochloride mixed of course with sulphanic acid; the necessity for removing large quantities of tin as sulphide is thus avoided. After separating the mother-liquors containing the stannic chloride, and washing with a little cold water, dilute soda solution is added to the crystalline mass until it is in slight excess over that required to combine with the sulphanic acid and with the hydrochloric acid of the amido-naphthol hydrochloride; this may be known by the mixture rapidly becoming brown on the surface exposed to the air; a little hydrogen sodium carbonate is then added sufficient to neutralise the excess of sodium hydroxide. In this way

free amido- β -naphthol is obtained suspended in a solution of sodium chloride and sodium sulphalinate. As the base is almost insoluble in water and in sodium carbonate solution, it can be collected on a vacuum filter, washed with water, and converted into the hydrochloride by hydrochloric acid. The yield of crystallised amido- β -naphthol hydrochloride is from 34 to 38 per cent of the weight of the β -orange. This agrees almost exactly with the result obtained by Liebermann with the double tin salt by means of hydrogen sulphide and ether (30 per cent base or 38.3 per cent hydrochloride). One of the sources of loss in the preparation of amido- β -naphthol in this way appears to be the regeneration of naphthol; at least I have always found β -naphthol in the product usually to the amount of 4 to 5 per cent.

Even when thus simplified, however, the process just described is more troublesome, and takes more time than the conversion of β -naphthol into the amido-naphthol through the nitroso-compound, the details of which I have slightly modified. The nitroso- β -naphthol, which is easily prepared from β -naphthol by treatment with nitrosyl sulphate, or sodium nitrite and an acid, is dissolved in dilute soda, filtered, and precipitated by a strong solution of soda. The green sodium compound, after being washed once or twice with dilute soda, is at once treated with hydrogen sulphide, which quickly reduces it to amido- β -naphthol. This is collected, washed with hydrogen sulphide solution, and converted into the hydrochloride, the yield being 73 to 75 per cent of the weight of the β -naphthol originally taken.

Now, as the commercial value of β -naphthol is not more than half that of β -naphthol orange, and since it yields twice as much amido-naphthol, it follows that to produce a given quantity of β -naphthaquinone, the cost of original material will be four times as great if Liebermann's process be employed as with that originally proposed by Stenhouse and myself, but what is even of more importance in research, his process is the more troublesome and tedious.

It has also been suggested that α -naphthol orange is a good source for the preparation of α -naphthaquinone. It has not, however, even the advantage of being a commercial product; moreover, the α -orange seems to be a mixture of two isomeric azo-compounds; at least, on reducing it with stannous chloride and hydrochloric acid, two amido-naphthol hydrochlorides are produced, one of which—the least soluble—does not yield α -naphthaquinone when treated with oxidising agents, and appears to be identical with the amido- α -naphthol obtained by the action of reducing agents on yellow nitroso-naphthol.

I have also employed hydrogen sulphide in presence of excess of soda or ammonia as a reducing agent for naphthol orange. With the α -orange the results were unsatisfactory. With the β -orange the yield of amido- β -naphthol hydrochloride was sensibly the same as that obtained by Liebermann's method, and affords a ready method of preparing small quantities of amido- β -naphthol.

Preparation of β -Naphthaquinone.—In preparing either α - or β -naphthaquinone from the corresponding amido-compounds, I have discontinued the use of chromic mixture, and employ ferric chloride instead, as the oxidising agent. It has the advantage in the case of β -naphthaquinone, that, even if used in excess and allowed to stand some time in contact with the precipitate, the quinone does not undergo any change, whilst with the more energetic chromic mixture it is attacked, and brown amorphous products are formed.

I hope in a future communication to describe some of the products obtained from β -naphthaquinone and from the amido-naphthols.

Mr. MELDOLA stated that soon after the publication of Liebermann's note he had tried the process and experienced the difficulties mentioned by Mr. Groves, but by using ammonium sulphide instead of stannous chloride he had obtained good results.

* Read before the Chemical Society, June 15, 1882. Communicated by the Author.

he says many chemists adopt as representing aluminum, must be too high, while 13.75, the number assigned by Dumas, is in all probability accurate. In support of this view it is calculated that, if $Al = 14$, the alumina obtained in the above described experiment should have weighed 3.590 grms; whereas, with $Al = 13.75$, its weight should have been 3.624 grms. In getting these figures O is taken $= 8$.

But, if the minute quantity of sodium stated to have existed in the metal used be deducted, and allowed for as sodium oxide (aluminate) in the last weighed residue, and if the results obtained be calculated, for alumina $= Al_2O_3$, with Stas's number for oxygen (15.96), the atomic weight of aluminum will be represented by 27.068, a number much nearer to 27 than to 27.5 (13.75 $\times 2$), the value assumed as most probably correct by Tissier.[†]

8. *Experiments of Terrell, 1879.*—Lastly, about a year ago Terrell[‡] made a determination of the constant in question by passing hydrochloric acid gas over metallic aluminum, collecting and measuring the hydrogen evolved. He placed a known weight of aluminum in a tube of hard glass, the tube wrapped with foil so as to allow of its being made red-hot. By one end a stream of well dried gaseous hydrochloric acid could be introduced, while a smaller tube extended from the other end and dipped into a vessel of water.

The air was first expelled from the apparatus by a current of dry carbon dioxide, and not until the gas passing through was capable of being completely absorbed by a solution of potash was the hydrochloric acid introduced, this latter itself freed from atmospheric air. The gas escaping from the tube was now collected in a graduated jar, and the temperature of the tube containing the aluminum was raised to a red heat. As soon as hydrogen ceased to come over, the gas in the jar was shaken up with potash to absorb any carbon dioxide which it might contain, and the volume was measured, and reduced by calculation to its equivalent under normal temperature and pressure. The aluminum chloride left in the tube was pulverulent and snow white.

No details are given of the method by which pure metallic aluminum was prepared, although this has been the great difficulty in the way of obtaining accurate results from experiments made with the metal as the starting point, nor is there any record of the tests applied to prove the purity of the metal used. The gas was collected over water, in which hydrogen is not altogether insoluble, and from which more or less of the gases of atmospheric air would be given off into the hydrogen. Nothing is said of the vapour of water, mixed with the hydrogen in proportion depending upon the temperature, having been removed, or its amount calculated and allowed for; though as it is not likely that so obvious a precaution was neglected, it may be supposed that the potash spoken of as used to absorb any carbon dioxide left was either solid hydrate or so strong a solution as to have also removed most if not all the aqueous vapour.

The results of the single experiment reported were—

| | | |
|----------------------------------|-------|-------------|
| Weight of aluminum | .. .. | 0.410 grm. |
| Volume of hydrogen collected at | | |
| 11° and 768 mm. | .. .. | 530 c.c. |
| Corresponding volume at normal | | |
| temperature and pressure | .. .. | 508.2 c.c. |
| Weight of this hydrogen | .. .. | 0.0455 grm. |
| from which the author calculates | | |
| 0.0455 : 0.4100 = 1 : 9.01, | | |

* This ought to read 3.594.

† Since this paper was printed in the *Philosophical Transactions* my attention has been drawn by Prof. W. F. Clarke, of Cincinnati, to a single other determination made in 1868 by Lenard (*Comptes Rendus*, 66, 508). The report of this is very brief and without any satisfactory details, the whole of it being the following lines: "The process employed by the author consists in attacking the metal by hydrochloric acid. He finds that 9 grms. of aluminum, attacked by pure hydrochloric acid, invariably give, after calcination, 17 grms. of alumina; whence he concludes that 9 would represent the equivalent of aluminum as referred to hydrogen taken as unity."

‡ *Bulletin de la Société Chimique de Paris*, 31, (Fév. 20, 1879), 153.

giving the atomic weight 13.515 (for Al_2Cl_3) or 27.03 (for $AlCl_3$).

In verifying the above calculation I have found as the result of reducing the volume of hydrogen from the given to normal temperature and pressure 514.85 c.c. instead of 508.2 c.c., but this, I am satisfied, arises from the number representing the pressure at the time of experiment being, doubtless by a printer's error, wrongly given as 7.68 instead of 7.58 m.m. With the latter figures the result is as recorded in the paper, and of course such atmospheric pressure is more frequently observed than that which appears in the above table.

It is pretty plain that from the researches which have been quoted we may reject those of Davy, Thomson, and Mather as incapable of giving exact results, this being either admitted by the authors themselves or shown by an examination of their methods and the inconsistency of their conclusions. Our knowledge of the atomic weight under consideration rests therefore upon the investigations of Berzelius, Tissier, and Terrell, each of whom made one experiment, and those of Dumas, who made seven.

General Results of Former Determinations.—If all the results be taken as I have re-calculated them, using Stas's atomic weights for the other elements concerned, and equal value be given to all, we shall have the following arithmetic mean—

| | | |
|-----------|-------|--------|
| Berzelius | .. .. | 27.237 |
| Dumas | .. .. | 27.447 |
| " | .. .. | 27.096 |
| " | .. .. | 27.435 |
| " | .. .. | 27.318 |
| " | .. .. | 27.522 |
| " | .. .. | 27.327 |
| " | .. .. | 27.489 |
| Tissier | .. .. | 27.068 |
| Terrell | .. .. | 27.030 |
| Mean | .. .. | 27.357 |

If, however, the results of Dumas, all depending on repetition of the same process, be viewed as possibly affected by some constant error, and be thrown together, taking into the calculation the mean only of his seven experiments, the general mean will be—

| | | |
|--------------|-------|--------|
| Berzelius | .. .. | 27.237 |
| Dumas (mean) | .. .. | 27.462 |
| Tissier | .. .. | 27.068 |
| Terrell | .. .. | 27.030 |
| Mean | .. .. | 27.199 |

If we separate Dumas's results, and take the mean of the other three, we get in contrast—

| | | |
|--------------|-------|--------|
| Berzelius | .. .. | 27.237 |
| Tissier | .. .. | 27.068 |
| Terrell | .. .. | 27.030 |
| Mean | .. .. | 27.112 |
| Dumas (mean) | .. .. | 27.462 |

Or, if we throw together only the numbers obtained by Tissier and Terrell, which come nearest to each other, we have—

| | | |
|--------------|-------|--------|
| Tissier | .. .. | 27.068 |
| Terrell | .. .. | 27.030 |
| Mean | .. .. | 27.049 |
| Berzelius | .. .. | 27.237 |
| Dumas (mean) | .. .. | 27.462 |

Values now generally adopted for Atomic Weight of Aluminum.

The number adopted in some of the more recent chemical handbooks, reports, &c., may be quoted as follows:—

| | |
|---|-----|
| Gmelin: Handbook of Chemistry (Cav. Soc. Trans.) .. | 274 |
| Watts: Dictionary of Chemistry, First Supplement .. | 274 |
| W. A. Miller: Elements of Chemistry, 4th edit. .. | 275 |
| Meymott Tidy: Handbook of Modern Chemistry .. | 275 |
| Frankland: Lecture Notes for Chemical Students .. | 275 |
| Thorpe: Quantitative Chemical Analysis .. | 276 |
| Agenda du Chimiste (Wurtz's Laboratory, 1879) .. | 275 |
| Annuaire du Bureau des Longitudes, 1876 .. | 274 |
| Nauget: Principes de Chimie, &c., 3e ed. .. | 275 |
| Fittica: Jahresh. üb. d. Fortsch. d. Chemie, 1878 .. | 274 |
| Roscoe u. Schorlemmer: Ausf. Lehrbuch d. Chemie (Ger. ed.) .. | 273 |
| Fresenius: Anleit. z. quant. chem. Analyse, 5te Aufl. .. | 275 |
| Classen: Grundr. d. anal. Chemie (quant.) .. | 273 |
| Kohlrausch: Leitfaden de Prakt. Physik, 2te Aufl. .. | 274 |
| Mendeleeff: Paper on the "Periodic Law" (transl.) .. | 273 |
| J. P. Cooke, Jr.: The New Chemistry .. | 275 |
| J. D. Dana: System of Mineralogy, 5th ed. .. | 275 |
| E. S. Dana: Text-Book of Mineralogy .. | 273 |

New Experiments by the Author.

During the last three years I have devoted a large part of my leisure time to a re-determination of this atomic weight, sparing no pains to attain as precise a result as possible, and aiming especially at the discovery, and as far as possible the removal, of sources of error connected with the methods employed. The following general principles have been kept in view:—

1. That each process used should be as simple as possible, and should involve as little as possible of known liability to error.
2. That different and independent processes should be resorted to as the means of checking each other's results, even though it may fairly be assumed that one is more advantageous than another.
3. That each process should be carried out with quantities of material differing considerably from each other in successive experiments.
4. That only such other atomic weights should be involved as may be counted among those already known with the nearest approach to accuracy.

The most scrupulous care was taken in the purification and examination of all the reagents used, and as far as possible vessels of platinum or of hard porcelain were substituted for those of glass.

Means and Method of Weighing Employed.—For the weighings an excellent balance, of Becker's construction, was employed. It was in perfect order, carefully adjusted (especially as regards centre of gravity of beam with average load to be carried), and would bear safely 200 grms. in each pan, giving when thus loaded a deflection of the index to the extent of 15 division of the scale over which it moves for a difference of weight of 0.0001 grm. All weighings were made by the well-known method of observing the vibrations of the index on either side the position of rest. In one series of experiments *absolute* weights were required, i.e., real equality of weight between the quantities of matter dealt with and the standards of weight with which they were compared; in these cases the method of "double weighing" was made use of, so as to eliminate any error arising from inequality in length of the arms of the balance. In view of this need, in connection with a part of the research, for absolute weights, directly comparable with those used by Regnault in his determination of the density of hydrogen, I applied to my friend J. E. Hilgard, Esq., in charge of the office of the United States Coast Survey at Washington, for a comparison of a kilogramme with a weight of the same denomination belonging to the Coast Survey, the value of which latter weight is accurately known in terms of the original "kilogramme of the Archives" at Paris. He kindly had this comparison made, and sent me the results in detail, showing that my weight was 8.1 milligrammes

heavier than the "star kilogramme" which is the standard of reference at Washington (both *in vacuo*), with an uncertainty of comparison not exceeding 0.1 milligramme, while the "star kilogramme" is certified to as agreeing with the normal "kilogramme of the Archives" within 1.1 milligramme. I had already a 10-gramme weight, professedly normal, but, as it turned out, too light by a very minute fraction of its value, and with these two, checked against each other, a full series of comparisons was made of all the other weights to be employed, the specific gravity of each piece being determined before its final comparison as to weight, so that the real values might all be referred to a vacuum by calculation of the buoyancy in air. Determinations of the specific gravity of all materials and vessels which had to be made were also made, and the barometer and thermometer being observed at the time of each weighing, all weights hereafter mentioned in this paper represent real values *in vacuo*.

Three separate series of experiments were made, by methods to be presently stated. A fourth series was attempted, involving the conversion of metallic aluminum into oxide and determination of the amount of oxygen taken up, but this process was found to be attended with much difficulty from various causes, amongst others from the liability to loss by spitting if the metal were treated with acid in open or small vessels, from the necessity of transfer to such vessels for final ignition if larger ones were at first used, and from the appreciable solubility of the hydrate of aluminum if this were precipitated in order to avoid evaporation of the original solution. The few results obtained in this way agreed generally with those of the other methods, but varied among themselves within unsatisfactorily wide limits, and were manifestly not deserving of equal confidence. Hence the work was not pushed further in this direction.

(To be continued.)

ON THE SOLUBILITY OF SULPHUR DIOXIDE IN SULPHURIC ACID.*

By J. T. DUNN, M.Sc.

HAVING determined the solubility of sulphur dioxide in concentrated sulphuric acid at the ordinary temperature, as stated in my note of last January (*Transactions*, vol. v., p. 39), I thought it would be desirable to extend the determinations to other temperatures and to other strengths of acid. I first set about determining the solubility in concentrated acid at different temperatures, and since for obvious reasons, the method of direct weighing would be inapplicable, it was necessary to use some method in which a known quantity of the saturated acid could be withdrawn at the temperature of the experiment and its content of SO_2 determined.

I consequently made use of the apparatus described by Bunsen in his "Gasometry," with a very slight modification. A large test-tube was fitted with a cork pierced by three holes: through the first a thermometer was inserted; through the second passed the tube from the SO_2 supply down to the bottom of the test-tube; and through the third passed a glass tube bent twice at right angles, which served as exit tube for the superfluous gas while the saturation was going on, and which, by simply pushing it down through the cork until it dipped beneath the acid, was converted into a delivery tube for the saturated acid.

In this apparatus was placed about 50 c.c. of the acid to be saturated, and the whole was then placed in a large beaker of water, which could be kept at any temperature by the help of a Bunsen burner and an electric thermostat. The temperature indicated by the thermometer in the acid

*A Paper read before the Newcastle-upon-Tyne Chemical Society, March 23, 1882.

never varied more than half a degree during the whole time of an experiment. Through the acid in the apparatus was now passed a moderately rapid current of SO_2 , prepared from copper and pure sulphuric acid, and carefully dried, for lengths of time sufficiently great to insure the complete saturation of the acid. The exit tube was now pushed down into the acid (and beneath the level of the SO_2 delivery tube, so as to avoid accidental entrance of bubbles into it), and of course the pressure of the SO_2 still entering the vessel forced the liquid out through the tube. It was permitted to flow into a small stoppered bottle, the capacity and weight of which were known; the delivery tube went to the bottom of the bottle, and the acid gradually and quietly displaced the air. When the bottle was full and had overflowed for some time, the delivery tube was slowly withdrawn and the stopper immediately inserted. In this way a known volume of the saturated acid was obtained, without any escape of SO_2 , and it had now to be weighed and the SO_2 determined by chemical means.

I intended at first to use Bunsen's method of titration by iodine and hyposulphite, but the trouble of preparing the large bulks of air-free, distilled water necessary to dilute the acid induced me to seek for another method. I tried at first direct titration with permanganate, but I soon found that unless very large bulks of fluid were used the escape of SO_2 from the liquid during titration was a serious source of error. I then tried sinking the acid under excess of permanganate, and titration with excess of ferrous sulphate and permanganate, but finally settled down to bichromate. The bottle containing the weighed quantity of saturated acid was opened under a known quantity of standard bichrome solution, time was allowed for the complete diffusion of the acid out of its bottle, and then the unaltered bichrome was determined by adding excess of standard ferrous sulphate and titrating back with bichrome.

The weight of SO_2 determined in this way was calculated into its volume at normal pressure and temperature. The weight of the saturated acid minus the weight of SO_2 found gave of course the weight of the sulphuric acid in which the gas was dissolved, and from this was calculated its volume. These figures, together with the barometric pressure during the experiment, furnish the data for calculating the coefficient of solubility at the temperature of the experiment.

The capacity of the bottle was found, by weighing it empty, and again filled with distilled water of known temperature, to be 3.058 c.c.

The accompanying Table gives the principal observations and the results obtained at the different temperatures stated in the Table, the two results by the method of direct weighing being incorporated along with the rest for comparison. It will be seen that the solubility diminishes very rapidly as the temperature rises. The only figure which calls for any note is that representing the solubility at 1°C . This figure is permitted to remain, but is only an approximation to the truth, because the acid saturated at that low temperature was of course supersaturated at the ordinary temperature of the air, and I did not dare to weigh the bottle, lest the stopper should blow out and gas be lost, but plunged it at once under bichrome. The weight, and hence the volume of the sulphuric acid are, therefore, not known exactly, but the figure is probably not far from the truth.

I attempted now to determine the solubility in acids of different strengths at about the ordinary temperature. As the passage of dry gas through dilute acids involves the carrying off of a certain amount of moisture, and the consequent alteration of the composition of the acid, it would seem that the chemical method is here inapplicable, and I had recourse at first to a determination by direct weighing. A known quantity of the acid used was saturated in the apparatus originally used, and a weighed drying tube was attached to the exit tube during the passage of the gas, so as to catch any moisture carried off by the SO_2 .

This tube was again weighed at the end of the experiment, and from the gain in weight any alteration in the composition of the acid used could be easily calculated. Sulphuric acid being out of the question for the drying tube, I used at first the ordinary porous calcic chloride, but I found that that substance absorbed SO_2 , probably by simple mechanical diffusion into its pores, to such an extent, and that the SO_2 so absorbed was so slowly given off again, as to render the guard-tube quite useless. I found that by substituting pure fused chloride for the ordinary vesicular stuff this difficulty was avoided, and that the tube could be readily cleared of SO_2 by blowing dry air through for a minute after detaching the guard-tube from the apparatus.

The dilute acids used were prepared by mixing concentrated acid of 1.840 sp. gr. with water, and their composition was inferred from a determination of their specific gravity.

Two sets were prepared, the first by endeavouring to obtain acids containing about 20, 40, 60, and 80 per cent H_2O , while in the second set I aimed at producing acids containing some definite number of molecules of H_2O to each molecule of H_2SO_4 . The following Table gives the specific gravities and composition of these acids:—

| Acid. | Sp. Gr. | Per Cent H_2O . |
|--|---------|---------------------------------|
| a | 1.703 | 22.7 |
| b | 1.482 | 47.7 |
| c | 1.300 | 60.8 |
| d | 1.139 | 80.8 |
| $\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ | 1.753 | 18.3 |
| $\cdot 2\text{H}_2\text{O}$ | 1.626 | 29.4 |
| $\cdot 4\text{H}_2\text{O}$ | 1.456 | 44.2 |
| $\cdot 10\text{H}_2\text{O}$ | 1.257 | 66.0 |
| $\cdot 20\text{H}_2\text{O}$ | 1.151 | 79.3 |
| $\cdot 50\text{H}_2\text{O}$ | 1.067 | 90.2 |

All of these last acids contain rather more water than corresponds to the formulæ assigned to them.

The results of these determinations are given in the Table (Experiments 10 to 19).

In the case of the more dilute acids, one or two of the weighings of the guard-tube exhibited anomalies which I found it rather difficult to account for, although I believe it was due to the water which had been caught in the tube taking up SO_2 in the stream of gas, and slowly giving it out again when the tube was filled with air. Although they were not very large, still they led one rather to doubt the figures obtained for the three most dilute acids. On examining the figures for the increase of the weight in the guard-tube throughout the whole series, however, I found that the amount of water carried away by the SO_2 in the course of an experiment was never sufficient, even with the most dilute acid, to render the composition of the acid at the end of the experiment perceptibly different from that at the beginning, and I therefore resolved to repeat some of the determinations by the chemical method. This was done, and the results (Experiments 20 to 26 in Table), show a very satisfactory agreement with those obtained by the other method, except in the case of the acid $\text{H}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$, in which case I am inclined to trust entirely to the lower figure given by the chemical method, believing that the other is influenced by the source of error just mentioned.

On examining the figures for acids of different strengths, although, unfortunately, from the temperature not having been kept constant throughout the determinations, the results are not exactly comparable with one another, we notice at once, whether we compare the solubility in H_2SO_4 at 11° with the set of low-temperature determinations of acids a to d, or the solubility in H_2SO_4 at 16° with the coefficients for the other set of acids at near the same temperature, that the addition of water to H_2SO_4 at first lowers the solubility coefficient. A comparison of the figures for the acids H_2SO_4 , 1, 2, 4, &c., H_2O shows us that the coefficient diminishes rapidly on the addition of

| Number of Experiments. | Acid used. | Temperature, Centigrade. | Barometer, Mm. | Weight of Saturated Acid. | Specific Gravity at Temperature of Experiment. | Weight of SO_2 absorbed. | Volume at Normal, c.c. | Weight of H_2SO_4 . | Specific Gravity near 15°C . | Volume near 15°C . | Observed Coefficient. | Coefficient at 700 mm . |
|------------------------|--|--------------------------|----------------|---------------------------|--|-----------------------------------|------------------------|-------------------------------------|---|-----------------------------------|-----------------------|-----------------------------------|
| 1. | H_2SO_4 | $17^\circ 0$ | — | — | — | — | — | — | — | — | — | 28.74 |
| 2. | — | $16^\circ 1$ | — | — | — | — | — | — | — | — | — | 28.86 |
| 3. | — | $11^\circ 1$ | 752.9 | 5.5744 | 1.823 | 0.2763 | 96.36 | 5.2981 | — | 2.879 | 33.46 | 33.78 |
| 4. | — | $26^\circ 9$ | 763.5 | 5.5733 | 1.822 | 0.1632 | 56.92 | 5.4101 | — | 1.940 | 19.36 | 19.87 |
| 5. | — | $42^\circ 0$ | 770.4 | 5.5702 | 1.821 | 0.1097 | 38.66 | 5.4645 | — | 1.3070 | 13.00 | 12.84 |
| 6. | — | $50^\circ 9$ | 773.3 | 5.5595 | 1.818 | 0.0832 | 28.68 | 5.4773 | — | 1.077 | 9.63 | 9.47 |
| 7. | — | 62.3 | 766.6 | 5.5552 | 1.816 | 0.0632 | 21.71 | 5.4930 | — | 0.985 | 7.27 | 7.21 |
| 8. | — | 84.2 | 759.4 | 5.5320 | 1.809 | 0.0388 | 13.55 | 5.4932 | — | 2.985 | 4.54 | 4.54 |
| 9. | — | — | 753.4 | — | — | 0.4256 | 152.00 | — | — | $3.000?$ | 50.67 | 51.11 |
| 10. | Acid (a) | $9^\circ 8$ | 760.0 | — | — | 1.0758 | 375.25 | 22.0135 | 1.703 | 12.926 | 29.03 | 29.03 |
| 11. | (b) | $8^\circ 6$ | 766.1 | — | — | 1.0522 | 576.20 | 21.2270 | 1.482 | 14.323 | 40.23 | 39.91 |
| 12. | (c) | $6^\circ 9$ | 759.6 | — | — | 1.8069 | 630.16 | 18.0645 | 1.300 | 13.895 | 45.35 | 45.38 |
| 13. | (d) | $6^\circ 9$ | 759.1 | — | — | 2.1609 | 756.75 | 17.7300 | 1.139 | 15.566 | 48.61 | 48.67 |
| 14. | $\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ | 16.4 | 758.8 | — | — | 0.8644 | 281.23 | 33.5783 | 1.753 | 13.451 | 20.91 | 20.94 |
| 15. | $\cdot 2\text{H}_2\text{O}$ | 15.7 | 770.6 | — | — | 0.9515 | 331.84 | 20.9590 | 1.626 | 12.888 | 25.75 | 25.39 |
| 16. | $\cdot 4\text{H}_2\text{O}$ | 16.7 | 771.6 | — | — | 1.0690 | 372.81 | 18.5345 | 1.456 | 12.724 | 29.30 | 28.86 |
| 17. | $\cdot 10\text{H}_2\text{O}$ | 14.1 | 756.9 | — | — | 1.0412 | 363.12 | 14.1798 | 1.257 | 11.279 | 32.24 | 32.40 |
| 18. | $\cdot 20\text{H}_2\text{O}$ | 16.8 | 767.5 | — | — | 1.0082 | 351.61 | 12.6983 | 1.151 | 11.032 | 31.87 | 31.56 |
| 19. | $\cdot 50\text{H}_2\text{O}$ | 15.5 | 780.4 | — | — | 1.3112 | 457.28 | 12.9204 | 1.067 | 12.106 | 37.77 | 36.78 |
| 20. | $\cdot \text{H}_2\text{O}$ | 15.0 | 752.0 | 5.3187 | 1.739 | 0.1739 | 60.63 | 5.1448 | 1.753 | 2.941 | 20.62 | 20.83 |
| 21. | $\cdot 2\text{H}_2\text{O}$ | 15.6 | 753.9 | 4.9203 | 1.609 | 0.2076 | 72.39 | 4.7127 | 1.626 | 2.898 | 24.98 | 25.17 |
| 22. | $\cdot 4\text{H}_2\text{O}$ | 15.1 | 747.4 | 4.4590 | 1.458 | 0.2435 | 84.92 | 4.2155 | 1.456 | 2.891 | 29.37 | 29.87 |
| 23. | $\cdot 10\text{H}_2\text{O}$ | 14.8 | 744.3 | — | — | 0.2468 | 86.07 | — | 1.257 | 2.880 | 29.87 | 30.32 |
| 24. | $\cdot 10\text{H}_2\text{O}$ | 14.8 | 749.8 | 3.9058 | 1.277 | 0.2493 | 86.94 | 3.6565 | 1.257 | 2.909 | 29.89 | 30.30 |
| 25. | $\cdot 20\text{H}_2\text{O}$ | 15.2 | 741.9 | 3.5860 | 1.173 | 0.2570 | 89.63 | 3.3290 | 1.151 | 2.886 | 31.06 | 31.82 |
| 26. | $\cdot 50\text{H}_2\text{O}$ | 16.0 | 755.4 | 3.3702 | 1.102 | 0.2812 | 98.07 | 3.0890 | 1.067 | 2.895 | 33.87 | 34.06 |

water so as to reach a minimum between H_2SO_4 and $\text{H}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$; this minimum occurs probably at $\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$, for which acid the coefficient is little more than two-thirds of that for H_2SO_4 . On the further addition of water the coefficient again rises rapidly, though not quite so rapidly as it fell, so that the solubility in $\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ is almost the same as that in oil of vitriol. Beyond this point the coefficient slowly rises with dilution as far as the experiments go, and will, presumably, increase regularly until the coefficient for pure water is reached. Since these experiments were finished, I notice a quotation in "Watts's Dictionary" (3rd supplement), to the effect that Satschenow has determined the coefficients of solubility of CO_2 in sulphuric acids of different strengths, and that he finds that dilution of the acid brings down the coefficient rapidly from 0.932 for H_2SO_4 to a minimum of 0.666 for $\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$, whence again it slowly rises on further dilution until the coefficient for water is reached. It is interesting to note that not only does the minimum solubility of CO_2 correspond in position with that of SO_2 , but the proportion which the minimum coefficient bears to that for H_2SO_4 is nearly the same in both cases. The determination of the solubilities of other gases in dilute sulphuric acid, and in other liquids which form definite hydrates, would seem to be a field of inquiry in which interesting results might be expected.

One other point requires to be mentioned. After most of the above determinations were finished I came upon a statement of Berthier (*Ann. Chim. Phys.* [3], 7, 77) which I had not previously noticed, in which he says that SO_2 colours potassium bichromate green from formation of chromic sulphate and hyposulphate. Evidently the incomplete oxidation of SO_2 to dithionite instead of to sulphuric acid would be a fatal defect in the method, and I at once set to work to discover whether this formation of dithionite took place in the determinations. I prepared some calcic dithionate by Welter and Gays-Lusac's method, and a determination of the loss on heating and of the SO_2 produced by fusing it with nitre showed it to be practically pure, only containing a trace of sulphate. A weighed quantity of this was added to 100 c.c. of

acidified standard bichrome solution, and left for a day, at the end of which time not the slightest alteration of colour could be detected. The liquid was then boiled for ten minutes, and titrated after cooling. Reduction had taken place to an extent which indicated the conversion of about half of the dithionate into sulphate. Although then the action is rather slow, it is clear that dithionates are oxidised by boiling bichrome solution. Two equal volumes of solution of SO_2 were now added, each of them to 100 c.c. of standard bichrome solution. In the first the SO_2 was immediately determined by titration with ferrous sulphate and bichrome, while the second was boiled for fifteen minutes and allowed to cool before titrating. Both gave exactly the same result. It is evident from this, coupled with the former experiment, that no dithionate can have been present, and that the SO_2 must have been completely converted into sulphate.

LAW OF THE CONGELATION OF THE AQUEOUS SOLUTIONS OF ORGANIC MATTERS.

By F. M. RAOUULT.

THE apparatus employed in these researches is that which has already served for studying the point of congelation of alcoholic mixtures. The solution is constantly agitated; its temperature is slowly lowered some tenths of a degree below its point of congelation, and a portion of the same liquid, already frozen, is introduced. The supersaturation immediately ceases, and the ice appears in the form of little spangles, which multiply and float in the liquid. At the same time the thermometer rapidly rises to the normal point of congelation, and if the solution is dilute it remains absolutely steady for some minutes, after which the temperature falls again. There is then a minimum lowering below zero, and this minimum the author takes as the depression of the freezing-point. For one and the same solution this point is found always the same within about

1-root of a degree, provided that the thermometer is immersed in the liquid and that the latter is constantly agitated.

The author has pointed out in the memoir cited that for solutions of alcohol not containing more than 1 equiv. per kilo, of water, the lowering of the freezing-point is proportional to the weight of alcohol dissolved in a constant weight of water. He has ascertained that the case is the same with solutions of methylic alcohol, formic and tartaric acids, and sugar. We may therefore admit that the law established by Blagden for the mineral salts is applicable to dilute solutions of organic compounds. The author has experimented upon twenty-nine bodies selected so as to be as different as possible in their solubility, their chemical function, their constitution, and their molecular weight. The lowering of the freezing-points per gm. of substance dissolved in 100 grms. of water vary considerably and in the proportion of 1:20. Nevertheless if we multiply the reduction of temperature corresponding to 1 gm. by the molecular weight of the substance, we find a product almost constant. This product ranges between 17 and 20. We may therefore say that the molecules of different organic compounds dissolved in the same quantity of water occasion substantially the same depression in the freezing-point. This tends to show that in most cases the molecules of organic compounds are simply separated by the act of solution, and brought to one and the same state, in which they exert the same influence upon the physical properties of water.

The determination of the freezing-point of the solutions of organic compounds acquires thus a great practical importance. It may serve to verify the purity of bodies, to find the strength of their solutions, and to trace the slow alterations thus produced. But its most important application will be the determination of the molecular weights in the numerous cases where the determination of the vapour-density is impossible. If it is necessary to decide between several molecular weights of which some are multiples of others, we select the one which if multiplied by the fall of temperature due to 1 gm. of the substance in question gives the product 18.5, this figure representing the mean molecular decrease of the freezing-point of organic matters. The author has not yet met with a soluble organic body for which this rule leads to an erroneous or even questionable result.—*Comptes Rendus*.

PRELIMINARY NOTE ON DIDYMIUM.

By P. T. CLÈVE.

In 1874 (*Bulletin*, xxi., p. 246) I determined the atomic weight of didymium, using an oxide in which the spectro-scope detected the presence neither of lanthanum nor of yttrium. As a mean I fixed the atomic weight at 147. Subsequently M. Brauner (*Sitzungsberichte K. Akad. Wissen. Wien*, Dec. 4, 1881) determined the atomic weight at 146.6, which differs little from the value which I ascertained. Chemists who had previously determined the atomic weight of didymium have found numbers approaching 144. Quite recently I have received from M. Brauner a letter in which he informs me that he has since found the number 145.4.

I have always during the last years suspected the presence of a new element accompanying didymium, and I have made repeated efforts to find it. In the beginning of this year I have submitted to fractionated precipitations about 200 grms. didymium oxide extracted from gadolinite, and separated from the yttria earths with potassium sulphate by repeated precipitations. The atomic weight of the fraction precipitated first was 146; that of the last fraction was 142.

The examination of the ignition-spectrum showed in the last fraction rather strong rays of didymium and lanthanum, but also new rays, among which is one very

strong, and possessing the wave-length $\lambda = 4333.5$, according to an exact determination by M. Thalen. This ray belongs neither to didymium, lanthanum, yttrium, erbium, terbium, or to the Y of M. Marignac.

The first fraction having the atomic weight 146 gave merely a feeble trace of this ray. It is therefore evident that the metal which gives this ray is more basic than didymium, but less so than lanthanum. Samarium is less basic than didymium.

Having submitted didymium chloride to a series of fractionated decompositions by heat, I have found the same ray in the fractions which best resist decompositions, but I have not found a trace in the first fractions.

I have found the ray in the spectrum of the fractions which have been precipitated with formic acid, whence it seems to result that the formate is sparingly soluble like the formates of didymium and of the oxides of cerite. The double salt with potassium sulphate must also be sparingly soluble.

The ray 4333.5 was already observed in 1863 by M. Thalen in a mixture of lanthanum and didymium obtained by M. Bahr. He was not able to detect it in 1874, when examining the didymium and lanthanum prepared by myself. Hence I had eliminated it by the reiterated fractionations to which I had submitted the lanthanum and didymium. The metal which produces this ray appears to accompany didymium in most metals. It has been found in the impure didymium extracted from helleinite, monazite, eucolite, the orthite of Arenal, in cerite, and in gadolinite.

I have mentioned these facts to secure the right of continuing my researches upon didymium, for which I have made considerable preparations. I do not wish, however, to hinder chemists who, fortunately for science, are occupying themselves with the chemistry of the rare earths from pursuing their researches. On the contrary, I shall be satisfied if the facts pointed out above prove of service to them in their investigations. As it seems to me, there still exists an unknown element accompanying didymium, and not to give it a name, I propose to designate it provisionally as Di β , characterised by the strong ray $\lambda = 4333.5$.—*Comptes Rendus*.

SOME POINTS IN THE CONSTRUCTION OF AN APPARATUS FOR THE ACCURATE ANALYSIS OF GASES.*

By EDWARD W. MORLEY, of Hudson, Ohio.

(ABSTRACT.)

A. WHEN a certain method of determining the top of the pressure column is used, the conditions of most accurate measurement of varying volumes of gas are satisfied by making the column of mercury, which measures the pressure, equal in length to the part of the eudiometer which is filled with gas. In the usual form of the apparatus, the pressure column has to be longer, which immensely increases the difficulty of securing uniformity of temperature.

B. To define the top of the pressure column, I make a Jolly-point enclosed in the barometric vacuum; this makes the probable error at the top of this column evanescent. The whole error of the tension is therefore produced by the same uncertainty which produces the error in the observed volume. If now the Jolly-point is put at about the level of the top of the eudiometer tube, the probable error of the tension is the same part of the tension as the probable error of the observed volume is of the observed volume. This is the condition of the maximum accuracy.

C. To preserve the barometric vacuum over the pressure column, I shut off this column from communication

* Proceedings of the American Association for the Advancement of Science, vol. XXIX., Boston Meeting.

with the rest of the apparatus except at the instant of a measurement. The screw of the fine adjustment formerly described serves also this purpose. The vacuum is found to be even more permanent than that of a barometer.

D. An auxiliary pressure tube is employed for preliminary adjustment. The bore of this tube is but a millimetre, which secures two important advantages.

E. The eudiometer tube is graduated with fine lines not over the eight-thousandth of an inch wide, in half millimetres. The graduation is affected with no relative errors of the hundredth of a millimetre. A reading microscope is carried on a cylinder so solidly connected with the iron tripod of the apparatus that ten pounds produce a relative flexure of only a tenth of a millimetre. This microscope is brought nearly to the level of the mercury in the eudiometer when the column in the pressure tube reaches just to the Jolly-point. The microscope is made to give distinct vision of the graduation, and by Grunow's cathetometer fine adjustment, the terminal lines of the eye-piece micrometer are made to coincide with two millimetres of the graduation. The focussing movement now moves the microscope so that distinct vision is had of the meniscus, and the level of the mercury is read to the hundredth of a millimetre on the eye-piece micrometer, whose divisions now represent the divisions of the tube carried forward into its interior. A four inch objective, with an amplification of about sixty diameters, is thus utilised.

F. The probable error of this reading of the level of the meniscus cannot be separated from other probable errors incident to the observation, but the sum total of all the errors whatever is equivalent to no more than a probable error of one-hundredth of a millimetre in this determination: and in the calibration of the apparatus, made before much practice in the use of this reading arrangement, the probable error of a reading was the hundredth of a millimetre.

G. The probable error of a single determination of oxygen in air is less than the four-hundredth of one per centum.

H. The method of measurement is adapted to rapid computation. The whole reduction of three measurements in an analysis, so as to get the per centum of oxygen, takes less than two and a half minutes.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 15, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—J. Ferrier, J. Hodgkin, W. O. Nicholson, H. H. Robinson, G. H. Sharpe, G. Tarmay. During the evening a ballot was held, and the following gentlemen were declared by the Scrutators, Dr. Japp and Mr. J. M. Thomson, duly elected Fellows of the Society:—R. Alexander, B. Brauer, J. J. Dobbie, C. J. Ellis, W. L. Goodwin, D. E. Johnstone, T. W. Lovibond, R. W. Pullar, R. N. Wollenden.

THE PRESIDENT then called on Mr. C. E. GROVES to read a paper entitled "*Note on β -Naphthoquinone*." See p. 267.

Mr. A. G. PERKIN then read a paper entitled "*Contributions from the Dye-house of the Yorkshire College: On some New Compounds of Brazilain and Hæmatein*," by J. F. HUMMEL and A. G. PERKIN. Commercial logwood extra^d is dissolved in hot water, and on cooling, ammonia is added in slight excess. This solution is exposed to the air for two or three days, or air is aspirated through for several hours. A dark purplish granular precipitate of the ammonia compound of Hæmatein is gradually

deposited. This precipitate is collected and pressed, 40 grms. are dissolved in a litre of hot water, and 30 to 160 c.c. of acetic acid (sp. gr. 1.04) added. The solution is heated for some time on a steam bath, and then allowed to cool. The amorphous residue of Hæmatein is filtered off, re-extracted with hot dilute acetic acid several times, and the combined filtrates evaporated on the steam bath, when glittering crystals of Hæmatein separate out. These are filtered off, washed with acetic acid, then with water, and dried. Thus prepared, Hæmatein is sparingly soluble in water, alcohol, ether, and acetic acid; it dissolves readily in alkalies. Analyses indicated the formula $C_{16}H_{12}O_6$. The crystals are evidently identical with those described by Haberstadt and Reis (*Ber.*, xiv., 611). Hæmatein is destroyed by hot sulphuric acid; it, however, dissolves readily in cold concentrated sulphuric acid, producing a dark reddish brown solution. By adding hot glacial acetic acid very gradually to this solution until it is diluted to the extent of two or three times its bulk, an orange crystalline precipitate is gradually thrown down. This, on analysis, gave the formula $C_{16}H_{12}O_6SO_3$. The authors suggest the name sulphate of hæmatyl; it is insoluble in alcohol, ether, and benzol, but is slightly soluble in strong acetic acid and cold ammonia. By digesting this substance with water and alcohol, a reddish brown crystalline powder was obtained, having the probable formula $(C_{16}H_{12}O_6)_2SO_3$. By the action of hydrochloric acid in sealed tubes on Hæmatein a body was prepared having the formula $C_{16}H_{12}O_5Cl$, crystallising in minute scarlet needles. By the action of hydrobromic acid a similar substance containing bromine was obtained. From commercial Brazil extra^d, by a similar process to that employed in the preparation of Hæmatein, Brazilain was obtained; dried at 100° its composition is—



dried at 130° it was obtained anhydrous. By the action of sulphuric, hydrochloric, and hydrobromic acids, compounds were prepared corresponding to those prepared from Hæmatein. The tinctorial power of these new compounds is much greater than that of the original Hæmatein and Brazilain, and the colours are much faster. Although the authors did not form from Hæmatein a body similar to the cœrulein obtained from gallein, they are of the opinion that Hæmatein probably belongs to the class of phthalleins.

Mr. WARINGTON then read a paper "*On the Determination of Nitric Acid as Nitric Acid by means of its Reaction with Ferrous Salts* (Part II.)." The author described and exhibited the apparatus at present employed by Schloesing. The nitrate mixed with ferrous chloride and hydrochloric acid is introduced into a very small tubulated retort, the extremity of which dips under mercury. The air is expelled by a stream of carbonic acid. The retort is then boiled for eight minutes, and the gas evolved collected in a small jar containing caustic potash. This nitric oxide is converted into nitric acid by treatment with water and oxygen, and finally titrated with alkali. The method fails, however, with extremely small quantities of nitrates and in the presence of certain kinds of organic matter. The prejudicial effect of the organic matter is removed to some extent by boiling the contents of the retort to dryness, but with very small quantities of nitric acid the results were still too low. The author, by various improvements and modifications described below, has been able to estimate 98 to 100 per cent of the nitrogen, even when half a milligramme of nitrogen as nitre was used. Perfect exclusion of oxygen from the apparatus is essential. This is effected by mixing the hydrochloric acid used in the carbonic acid generator with cuprous chloride, and protecting its surface with a layer of oil. The carbonic acid is always kept under pressure, so that any leak must be outwards. The nitric oxide is estimated by gas analysis, preference being given to absorption over caustic potash, after successive treatments with oxygen and pyrogallol. In the introduction of the oxygen a gas delivery tube in-

vented by Prof. Bischof was found of great service. It consists of a test-tube, with a minute perforation about $\frac{1}{4}$ inch from the mouth. The tube being filled with gas, has its mouth closed by an india-rubber cork, through which passes a short glass tube with a fine orifice. On tilting the tube under mercury with the perforation downwards, minute bubbles of gas rise from the perforated stopper closing its mouth, and thus the quantity added can be regulated with great accuracy.

The SECRETARY then read a paper "On a New Process of Bleaching," by J. J. DONBIE and J. HUTCHESON. The authors give a *résumé* of the history of the use of chlorine for bleaching. They then give an account of some experiments in which they have generated the chlorine by the electrolysis of dilute hydrochloric acid. The most satisfactory liberation of chlorine was obtained with a low battery power. In all cases Turkey red cloth was used as the fabric to be bleached. The best results from a practical point of view were obtained by steeping the cloth to be bleached in sea-water and passing the fabric between a series of carbon rollers, the upper row of which was connected with one pole, the lower row with the other pole of a battery. The rollers were caused to rotate slowly, and thus pass the fabric from one end to the other. Hypochlorite is formed, and on subsequent immersion in acid the fabric is effectually bleached. It was found that when hydrofluoric acid was substituted for hydrochloric acid bleaching also took place.

The Society then adjourned over the summer recess.

PHYSICAL SOCIETY.

June 17, 1882.

The Physical Society met in Oxford by invitation of the President, and, after luncheon in the Hall of Merton College, by kind permission of the Warden and Fellows, the health of the Society was proposed by the President and responded to by Lord Rayleigh.

The usual meeting was then held in the Clarendon Laboratory, Professor CLIFTON, President, in the chair.

Dr. W. H. STONE exhibited and described an electro-dynamometer, specially designed for measuring the currents used in the medical applications of electricity. For this purpose a light suspended coil is an advantage, and Dr. Stone adopted aluminium, which, with equal conductivity to copper, weight for weight, is very much lighter than copper. No frame was used for the coil, which was tied up with silk and varnished, amber varnish such as used by photographers being recommended by the author for this and similar purposes as preferable to shellac. A bifilar suspension of the coil was adopted to give directive force to the coil, the threads being of silver-gilt wire drawn after gilding, and such as is used in making gold lace. It is preferable to platinum wire by reason of its lower resistance. Silver-gilt wire 1.500th inch in diameter has a resistance of 9.8 ohms per metre, whereas platinum of same dimensions measures 62.2 ohms. Aluminium wire can be drawn as fine as copper. Some difficulty has hitherto been experienced in making contacts with it for electrical purposes, but Dr. Stone believes he has overcome these. The gilt wire makes a good contact with it. The specific heat of aluminium is high, and hence it is recommended by the author for resistance coils. The threads of the suspension were hung from two little brass springs placed horizontally in line and capable of being adjusted to and fro so as to widen the distance between the points of suspension when necessary.

Mr. Varley, Prof. Perry, and others, offered some remarks.

Mr. BOSANQUET then described his application of the Faure accumulator charged by a dynamo-electric generator to the working of laboratory apparatus instead of the usual Grove or other battery. The net result of his experiments is that the accumulators charged for two hours

have sufficient energy to keep the apparatus employed running for a week, and hence it is unnecessary for him as heretofore to put up 30 Grove cells each day.

Prof. PERRY observed that a well-made Faure cell having the minium laid on in a uniform coat does not loose its charge nor develop local action as is done by those accumulators in which the minium is put into holes in the plates.

Prof. W. G. ADAMS then took the chair, while Prof. CLIFTON described some ingenious devices adopted by him in lecture experiments on electrostatics. These consisted of insulating glass stems with glass cups to hold sulphuric acid formed on the stems; also a form of key which by rapidly succeeding contacts brings the spot of light on the electrometer scale to rest without tedious swinging. He also described a form of lecture galvanometer, sine or tangent, which could be readily shewn in all its working to a large class, and exhibited a simple and inexpensive apparatus for measuring the focal length of a lens in six different ways according to what is known about the lens. The results showed that the apparatus was very accurate in its indications.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 23, June 5, 1882.

Double Salts Prepared by Fusion.—MM. Berthelot and Illosvay.—A thermo-chemical paper, not capable of useful abstraction.

Boiling-Point of Selenium.—L. Troost.—The author's experiments give numbers between 664° and 666°, whence he accepts 665° for the boiling temperature of selenium at pressures near to 760 mm.

A Calorimeter by Refrigeration.—J. Vielle.—The method of mixtures is certainly the most convenient for the measurement of a specific heat. Yet when the initial temperature of the body is comprised between 100° and 400° or 500°, special difficulties are met with which do not occur either higher or lower. In this interval the method of refrigeration would be precious if sufficiently exact. The following process seems to combine exactitude and simplicity: The author takes a small bottle of thin glass with a narrow neck and a double covering, between the two layers of which a good vacuum has been made before sealing the outer covering. The apparatus thus carries with it its own recipient, and the conditions of refrigeration remain always the same. By the neck of the bottle is introduced along with the thermometer an agitator, by means of which a constant temperature is introduced into the whole mass. In this manner are avoided those differences between the surface and the centre upon which the refrigeration method has hitherto been ship-wrecked.

Determination of the Specific Heats of Small Quantities of Substances.—MM. Thoulet and Lagarde.—This memoir cannot be intelligibly reproduced without the accompanying illustration.

A New Condensation Hygrometer.—A. Crova.—The author has found serious discrepancies between the results obtained respectively by Regnault's hygrometer and the psychrometer. In calm weather and in mean hygrometric conditions the two methods agree approximately, though Regnault's instrument shows lower indications. In a high wind and in low hygrometric conditions the discrepancy becomes enormous. The author describes an apparatus which he has had constructed by means of

which the dew-point can be found to 1-10th of a degree, independent of the agitation of the air.

Law of the Congelation of the Aqueous Solutions of Organic Substances.—F. M. Raoult.—See page 272.

Method for Determining the Ohm.—J. Joubert.—A mathematical paper, not capable of useful abstraction.

Influence of the Positive Electrode of the Battery upon its Chemical Work.—D. Tommasi.—The author has established the remarkable fact that the electromotor force of one and the same element may vary according as its positive electrode is of platinum or of carbon. An element, for instance, incapable of effecting the electrolysis of water or of a saline solution, although the calories liberated by the element were more than the calories absorbed by the decomposition of the electrolyte, if its positive electrode was of platinum, but became able to produce this decomposition if the positive electrode was of carbon. This fact has a great importance as regards the relation which the author seeks to establish between the calories evolved by the battery and those absorbed by the decomposition of the electrolyte, and he has accordingly examined it in detail. A magnesium-platinum element in dilute sulphuric acid ought, according to thermic data, to decompose water, but the decomposition does not take place. It is the same if we substitute copper or silver for the platinum of the battery, but if we employ in the same element a cylinder of graphite or retort-coke as a positive electrode the electrolysis is effected. According to M. Berthelot (*Comptes Rendus*, 1881, Nov. 7) two zinc-platinum elements in dilute sulphuric acid should not decompose a solution of potassium sulphate, but the author on employing two zinc-coke elements in dilute sulphuric acid has succeeded in electrolyzing a saturated solution of potassium sulphate with a brisk escape of gas at the two platinum electrodes, and transference of the acid to the positive electrode, and of the base to the negative electrode, and this in a few minutes and at the common temperature. According to M. Berthelot this electrolysis should require at least 103 calories, whilst it is actually obtained with 76 calories, and even less. A single zinc-coke element in dilute sulphuric acid decomposes potassium sulphate if the electrode of the voltameter is of copper, but not if it is of silver. The author has submitted several salts to electrolysis; the solutions all contained an excess of salt. The platinum wires of the voltameter were 0.4 m.m. in diameter, and plunged into the liquid to the length of 0.3 to 0.4 metre. The carbons employed were graphite or coke, previously heated to redness, and allowed to remain for six hours in contact with carbonic acid. The presence of this gas in the pores of the carbon retards polarization, and renders the action more intense and more lasting. The author's results may be briefly summed up as follows:—Two zinc-coke elements (= 77.4 cal.) decompose solutions of magnesium, zinc, cadmium, copper, manganese, and iron (ferrous) sulphates, and potassium chloride, bromide, and iodide.

Zinc Oxy-chloride.—G. Andié.—The association of zinc chloride with zinc oxide gives rise to hydrated oxy-chlorides, which are formed with liberations of heat varying but little.

Action of Carbon Disulphide upon Silicium.—A. Colson.—The author obtains a compound, $\text{Si}_2\text{C}_2\text{S}_4$, which, if heated in a current of oxygen, gives off sulphurous acid, and is transformed into $\text{Si}_2\text{C}_2\text{O}_2$ without change of weight. In these compounds the carbon cannot be detected by the usual means. There are obtained in contact with siliceous tubes bodies more oxygenated in a reducing atmosphere than in an oxidising one. The sulphur is tetrameric.

Preliminary Note on Didymium.—P. T. Clève.—See page 273.

A New Mono-chlorinated Camphor.—P. Cazeneuve.—Mono-chlorinated camphor has an odour like that of

camphor, a bitter and aromatic taste. It is more soluble in water than camphor or its bichlorinated compound. It is soluble in alcohol, ether, chloroform, carbon disulphide, and benzol. It melts at 83° to 84° , begins to solidify at 83° , but remains soft above 80° . It boils at 244° , and distils almost without decomposition at from 244° to 247° .

Spontaneous Fermentations of Animal Matters.—A. Béchamp.—The author considers that the microzymas in organisms are the agents chemically and physiologically active in the transformations which are effected during life and after death.

Die Chemische Industrie.

Vol. 5, No. 4.

Behaviour of Hyponitric Acid with Sulphuric Acid and the Process of Lanne and Benker in the Sulphuric Acid Manufacture.—G. Lunge.—Lanne and Benker have indicated a process which is to effect a great economy in the consumption of nitre, and which is theoretically based on the feeble affinity of hyponitric acid for sulphuric acid, and the ease with which the former is expelled from the latter. They assume that as the gases issuing from the chambers contain at least 5 per cent of oxygen, all the oxides of nitrogen present must be in the state of hyponitric acid, which, as it is completely expelled from its combination with sulphuric acid at common temperatures by a current of common air, or preferably of carbonic acid, is not absorbed in the Gay-Lussac tower. The absorption of the bulk of the nitrogen compounds in the Gay-Lussac tower is only to be explained by the presence of sulphurous acid, which converts the N_2O_4 into N_2O_3 , and the loss of nitre may be reduced to one-third if a sufficiency of sulphurous acid and aqueous vapour is allowed to mix with the gases at the foot of the Gay-Lussac tower. The author considers the assumption that the nitrogen compounds in the chamber gases are exclusively present as hyponitric acid not proven and improbable, and the supposition that the latter acid forms an unstable compound with sulphuric acid at 62°B. , decidedly erroneous. Prof. Lunge's experiments show that hyponitric acid is readily and completely absorbed by sulphuric acid at 60°B. , and the colourless solution formed is neither changed by prolonged heating to about 100° , nor by prolonged treatment with air, but behaves exactly like a mixture of sulphuric acid, nitrosyl-sulphuric acid, and nitric acid. This holds good at least up to the proportion of 10 m.g. nitrogen per c.c. of acid, which represents a very strong nitrosed. But though the theory of Lanne and Benker is inaccurate, the introduction of sulphurous acid may be advantageous on other grounds, especially in establishments which work with imperfect plants, e.g., if the absorption-space in the Gay-Lussac tower is too small or the excess of air is too large, in which case much nitrous acid escapes unabsorbed. By introducing sulphurous acid a part of the chamber-process is transferred to the tower. A favourable action of the sulphurous acid is conceivable from another point of view. If the Gay-Lussac tower is too wide, not all the molecules of the nitrous gas come in contact with the acid. Sulphurous gas if introduced will mix with the nitrous gases which are escaping between the falling drops of acid and retain them. But if an excess of sulphurous acid and watery vapour are present, the nitrosyl-sulphuric acid may be denitrated, and nitric oxide escape, thus causing a serious loss of nitrogen compounds.

Cosmos Les Mondes.

No. 3, May 20, 1882.

True Chemistry.—E. Maumené.—The author quotes and criticises a communication by M. Schützenberger (*Comptes Rendus*, p. 534) on the action of iodine and naphthalene. He considers that the reaction, of which the

Collège de France has made a misinterpreted study, shows that the principal action of iodine and naphthaline, necessarily beginning by the removal of hydrogen, does not give in any case $(C_{20}H_{12})_x$, or "naphthaline less two atoms of hydrogen." The reaction leads immediately to a substitution, and the production of $C_{20}H_{11}$. He considers that classical chemistry is, in theory, nothing but a long series of errors.

No. 4, 1882.

This issue does not contain any original chemical matter.

No. 5, 1882.

Certain Compounds of Nitrogen.—M. Maumend.—The compound HCl, H_2N , which the author can now form at the rate of 1 kilo. daily, has not the appearance of sal-ammoniac, and rather approaches potassium cyanate. If heated with potassa or soda it disengages a gas, H_2N , the odour of which is distinct from that of ammonia, and which is only about half as soluble in water. HN can also be easily obtained; it is a non-alkaline gas, almost insoluble in water, extinguishes bodies in combustion, and may be confounded with nitrogen.

In the matter of Letters Patent granted to Carl Daniel Ekman of Sweden, but now of 574, Old Broad Street, in the City of London, for the invention of "An improved method of treating wood in order to obtain fibre suitable for paper making and other purposes," bearing date the 13th day of July, 1881, No. 3062.

NOTICE IS HEREBY GIVEN that the said Carl Daniel Ekman has applied by Petition to the Commissioners of Patents for inventions for leave to file in the Great Seal Patent Office with the Specification of the said Letters Patent a Disclaimer and Memorandum of Alteration of certain parts of the said Specification, and any person intending to oppose such application must leave particulars of objection thereto at the office of the Solicitor-General, No. 21, New Court, Carey Street, London, within 21 days from the date of the "London Gazette" in which it is published.

And **NOTICE IS HEREBY ALSO GIVEN**, that after the expiration of the said 21 days no objection will be received or entertained, and the Solicitor-General will proceed to a hearing.—Dated this 23rd day of June, 1882.

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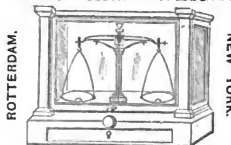
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THE CHEMICAL NEWS.

VOL. XLV. No. 1179.

ON THE ANALYSIS OF IRON AND STEEL, WITH SPECIAL REFERENCE TO THE ESTIMATION OF CARBON AND SILICON.*

By FRANCIS WATTS,

Student in the Chemical Laboratories of the Mason Science College,
Birmingham.

NOTWITHSTANDING the large amount of attention which has been given by chemists to the perfecting of the methods adopted for the estimation of the carbon and silicon in iron or steel, there remains much to be desired in reference to the processes for the estimation of the so-called "combined" carbon, and especially for the estimation of the silicon. Some doubts have arisen as to the condition in which the latter element occurs in iron; that is to say, it appears to be believed by some chemists that the silicon occurs in iron and steel in a state of chemical combination with the iron, forming a silicide, whilst others appear to favour the view that at least a portion of it exists there in a condition corresponding to that of graphite. Whatever may be the truth in regard to this point, it is certain that when a specimen of cast-iron, wrought-iron, or steel is treated with an acid, the insoluble residue generally contains a portion of the silicon in an unoxidised condition.

The processes commonly adopted for the estimation of silicon in general depend upon the conversion of the silicon into its oxide by the action of acids or of bromine or iodine, and the oxidation of the unoxidised silicon of the residue, either by roasting or by fusion with nitre. Another, and for certain purposes an excellent, process, proposed by Boussingault, consists in roasting a weighed portion of the iron in a muffle, whereby the iron is converted into oxide, the silicon into silica, and the carbon is burnt off. On subsequently exposing this mixture of oxides to the action of hydrochloric acid gas at a red heat, the iron is volatilised in the form of chloride, whilst the silica which remains in the boat can be weighed.

In none of these processes, however, is any distinction observed between the silica which results from the oxidation of the silicon and that which exists ready formed in combination with various bases in the form of mechanically intermingled slag or cinder. That this distinction is of real importance there can be no doubt, but no serious attempts have been made to get over the difficulty. In the usual process the slag, if present, is sure to be more or less decomposed by boiling with the acid, and the silica thus liberated goes to augment the quantity of that from which the proportion of silicon is calculated. If, as is sometimes the practice, the residue is boiled with solution of sodium carbonate, with the object of dissolving away the silica from the graphite and slag, an uncertainty is introduced into the result, from the impossibility of avoiding the introduction of more or less silica with the alkali, and also from the difficulty of operating without loss upon so small a quantity of material.

Bromine and iodine have both been suggested as substitutes for acids, and these agents do not act upon the slag, but the precautions to be taken and the length of time occupied make the operations very tedious.

For the estimation of the total carbon, the following methods have been generally adopted:—

1. Combustion of a weighed quantity of the iron in a porcelain tube in a stream of oxygen. The chief

objection to this process is the very high temperature required.

2. Combustion of the carbon in the residue, left when iron is dissolved by the aid of iodine in the presence of water, but the length of time required for solution is a great objection to this method.
3. The total carbon is frequently estimated by dissolving the iron in a solution of copper chloride or sulphate. The whole of the carbon is left in the residue. The presence of the finely-divided metallic copper with which it is mixed is rather an advantage than otherwise, for it assists the combustion of the graphite—a matter of some difficulty. The chief defect in this otherwise excellent process is that unless the vessel containing the iron undergoing solution is kept very cool, a decided smell is perceptible, probably indicating the evolution of hydrocarbons. The time required for solution, too, is somewhat lengthy.
4. Weyl's method for determining the total carbon is a modification of the above process, and consists in attaching a lump of the iron to be analysed to the positive pole of a battery, of one Daniell's cell, the negative pole consisting of a piece of platinum foil, the menstruum as before being a solution of a copper salt. But even in this case it is difficult to prevent the evolution of gas from the iron.
5. Lastly, the method of Wöhler, to which further reference will be made presently, consists in heating a weighed portion of the iron in chlorine gas, whereby the iron is volatilised as chloride; the residual carbon can then be submitted to combustion in the usual manner.

At Dr. Tilden's request I have undertaken some experiments with the object of avoiding some of the difficulties just referred to. Our first desire was to secure a process by which silicon could be rapidly and easily determined in iron and steel, and at the same time distinguished from the slag, which is almost invariably mechanically intermingled to a greater or less extent.

The action of chlorine at a red heat presented itself as a reaction which might be turned to account for this purpose, and after some preliminary trials the following process has been adopted:—

Divested of details it is briefly this. The total carbon is first determined by Wöhler's method, with the precautions to be described hereafter. Another weighed portion of the iron is similarly treated in a stream of chlorine, whereby not only the iron but the silicon, and probably the sulphur and phosphorus, are volatilised in the form of chlorides; the gas as it issues from the combustion tube is caused to bubble through water contained in a flask; the water in the flask immediately decomposes the silicon tetrachloride, which is carried forward with the excess of chlorine, and soluble silica results. The water is afterwards evaporated to dryness, and the silica recovered and weighed. Unfortunately the presence of manganese is the source of a little difficulty, for its chloride is not sufficiently volatile to be readily removed from the contents of the boat, by the stream of chlorine. Hence, when manganese is present, which is almost always the case, it is necessary to wash the residue in the boat before weighing. The residue, which consists of the total carbon and the slag, having been weighed, from this weight, the weight of total carbon previously determined is deducted, the difference being the amount of slag. Thus, in two simple and rapid operations, are determined, first, the total carbon; second, the silicon and slag.

Regarding the process more in detail, the following arrangements are recommended:—

It being necessary to obtain an efficient supply of chlorine which shall be well under control, some modification of the usual apparatus for generating the gas becomes desirable. A Wolff's bottle is filled with manganese ore in lumps; the necks are fitted with two tubes,

* Read at a Meeting of the Philosophical Society of Birmingham, May 11, 1882.

one of which passes to the bottom of the bottle, the other passes just through the cork, and is provided with a glass stopcock. The bottle is placed in a saucupan of water, arranged so that it can be heated. The longer tube is connected with a stoneware jar containing common strong hydrochloric acid, this jar standing on a higher level than the generator; a gentle heat being applied to the saucupan, a supply of chlorine is obtained which may be regulated at will. The stoppers should be of india-rubber, well coated over with paraffin.

The chlorine, before entering the combustion-tube, must be rendered perfectly free from air and moisture. To effect this the gas is passed through three wash-bottles, the first containing water, the others strong sulphuric acid. The oxygen is removed by passing the gas through a tube containing lamp-black, which has been strongly heated in a crucible for half an hour to free it from moisture and tarry matter, as well as to render it more coherent; the column of lamp-black is kept in position by plugs of gas carbon, and should be about 6 or 8 inches long, occupying only the central portion of the tube. In practice it was found that the chlorine always contained moisture after passing through this carbon tube, and to this cause the discrepancies in the amounts of silicon found in the earlier analyses were probably due, for it is of the highest importance that the combustion-tube should be quite dry. Much better results were obtained when a tube containing pumice moistened with strong sulphuric acid was introduced between the carbon tube and the combustion-tube.

The only part of the apparatus remaining to be described is the combustion-tube. This is a piece of ordinary combustion-tube, a portion of which, some five or six inches, is bent downwards, not drawn out, at an angle of about 110° , so as to conveniently dip into a flask about a third filled with water. The carbon-tube, together with the drying and combustion tubes, must be arranged to lie within the gutter of the combustion furnace,* the bent portion of the combustion-tube turned downwards and dipping into the flask placed at the end.

Having described the apparatus employed in this process it now remains to give an account of the method of procedure.

About 0.6 or 0.8 gram of cast-iron, or about three times that quantity of wrought-iron or steel, in the form of borings, small lumps, or wire, is weighed in a porcelain boat; this is then introduced into a straight combustion-tube, taking care that the carbon in the carbon-tube is heated fully to redness, and the air in the apparatus and combustion-tube quite displaced by chlorine before the boat is heated. A slow stream of chlorine is steadily maintained and the boat heated gently, just sufficient heat being applied to volatilise the ferric chloride as it is formed. The stream of chlorine must not be too rapid or there is a danger of particles of carbon being carried out of the boat. When the whole of the iron is removed the boat is taken out whilst still warm, allowed to cool, thus becoming freed from any traces of chlorine, and the carbon determined by combustion, in a separate tube, in oxygen in the usual way.

A similar quantity of the iron is weighed in another boat and the bent combustion-tube placed in the furnace, care being taken to free it entirely from any moisture. A flask of about 500 c.c. capacity containing about 100 or 150 c.c. of distilled water is arranged so that the extremity of the combustion-tube dips under the water; the air is carefully removed from the apparatus by passing a stream of chlorine, and the carbon-tube strongly heated. The boat is now introduced and the chlorine allowed to flow for a few minutes before heating; a gentle heat is now applied as in the previous instance, a higher temperature being induced towards the end of the operation.

When the whole of the iron is volatilised, a point most readily ascertained by the disappearance of red vapour,

the tube is allowed to cool, the stream of chlorine being maintained for a short time, and the boat and flask removed. On removing the boats they should in every case be at once placed in weighing tubes to preserve them from accident. The water is boiled whilst still in the flask, until free from chlorine, and then evaporated to complete dryness in a platinum dish, in the water-bath, the residue treated with a few drops of hydrochloric acid, well washed with warm water upon a filter, and ignited and weighed. This, less the filter-ash, gives the weight of SiO_2 , from which the percentage of silicon can at once be calculated. Should any silica adhere to the extremity of the combustion-tube it may be detached by a glass rod, the extremity of which is covered by a short length of india-rubber tubing, a few drops of solution of caustic potash being employed if necessary.

A filter is dried at 110°C ., enclosed in weighing tubes, and its weight ascertained; the contents of the boat are now emptied into this, well washed with hot water, and again dried at 110°C and weighed. This is the weight of the mixed total carbon and slag, the percentage of which must be calculated. From this the percentage of total carbon already determined is deducted and the remainder reckoned as slag. The proportion of slag can be checked by burning off the carbon from this mixture and weighing the residue. The object of washing the carbon and slag is to remove the less volatile chlorides. Earlier experiments, in which the washing of the residue was omitted, were far from satisfactory, for it was found impossible to entirely volatilise the chloride of manganese, which, when the boat and its contents were ignited in oxygen, formed black glittering crystals of oxide upon its side.

The process which has just been described appears at first sight to be complicated, but when the operator has a number of analyses to perform and is provided with two combustion furnaces, and the chlorine apparatus is once mounted, nothing is easier to carry out. The method enables the analyst to distinguish absolutely between the elemental and the oxidised portions of the silicon, and is specially distinguished for the short amount of time occupied. The removal of the iron from the sample by chlorine is accomplished in about quarter of an hour, and the combustion of the residue can be proceeded with immediately, as it is not necessary nor desirable to allow the combustion-tubes to cool down completely between the successive operations.

The only obvious source of error was at the outset enquired into and found not to exist. It was thought possible that on treating such a mixture as cast-iron contains of silica and graphite in chlorine gas a reaction would ensue leading to the evolution of carbonic oxide and silicon chloride. But a blank experiment upon a mixture of finely powdered blast-furnace slag and crystalline graphite, showed that the mixture sustained no loss of weight by heating in chlorine gas and no silica was found in the receiver.

The statements of different analysts concerning the proportions of slag in different varieties of pig-iron are so discordant among themselves that it appeared desirable to ascertain by direct experiment whether some of the other constituents of slag could not be recognised. Accordingly a specimen of No. 1 Staffordshire hot-blast pig was carefully bored under my own superintendence and the borings collected so as to be entirely free not only from dirt but from the sand adherent to the exterior of the pig. A portion of these borings was analysed. After prolonged treatment with aqua regia the insoluble residue dried at 120°C ., and consisting chiefly of a mixture of carbon and silica, amounted to 14.9 per cent. The chlorine process indicated 4.4 per cent of slag. A portion of the same iron dissolved in acid and the solution tested qualitatively for calcium gave decisive evidence of its existence. Aluminium, however, could not be detected.

The following analyses have been selected to illustrate the results obtained by this process, and different varieties of iron:—

* One of Griffin's long combustion furnaces was used.

PERCENTAGE OF SILICON AND SLAG.

| Description of Iron. | Weight of Iron taken. | Weight of Washed Residue = C+slag. | Percentage of C+slag. | PERCENTAGE OF SLAG. | Weight of SiO ₂ obtained. | PERCENTAGE OF SILICON. |
|------------------------------------|-----------------------|------------------------------------|-----------------------|---------------------|--------------------------------------|------------------------|
| Cast-Irons. — | | | | | | |
| I. White Staffs. . . . | 0'8860 | 0'0278 | 3'13 | 0'74 | 0'0122 | 0'64 |
| II. No. 1 Hematite. . . . | 0'8734 | 0'0363 | 4'04 | 0'07 | 0'0415 | 2'21 |
| III. No. 1 Hot-Blast Staffs. . . . | — | — | — | 4'40 | 0'2087 | 3'96 |
| IV. No. 2 " " " " " " | 0'4265 | 0'0174 | 4'08 | 0'62 | 0'0283 | 3'09 |
| V. No. 3 " " " " " " | 0'5562 | 0'0219 | 3'90 | 0'84 | 0'0488 | 4'09 |
| VI. Iron Wire | 3'3485 | — | — | — | 0'002 | 0'03 |
| Do. by nitric acid process | 3'5513 | — | — | — | 0'0018 | 0'024 |
| VII. Steel Wire | 0'5927 | — | — | — | 0'0044 | 0'34 |

* This proportion of slag appears enormous, but, as already stated, the residue left when this iron was dissolved in *aqua regia* amounts to 14'9 per cent. It appears to be an exceptional case.

PERCENTAGE OF TOTAL CARBON.

| Variety of Iron. | Weight of Iron taken. | CO ₂ obtained. | Percentage of Carbon. |
|------------------------------------|-----------------------|---------------------------|-----------------------|
| Cast-Irons. — | | | |
| I. White Staffs. . . . | 0'6947 | 0'0603 | 2'39 |
| II. No. 1 Hematite. . . . | 0'7945 | 0'1159 | 3'97 |
| III. No. 1 Hot-Blast Staffs. . . . | — | — | 3'15 |
| (By electrolysis). | | | |
| IV. No. 2 Hot-Blast Staffs. . . . | 0'5307 | 0'0675 | 3'46 |
| Do. | 0'6567 | 0'0799 | 3'45 |
| V. No. 3 " " " " " " | 0'7910 | 0'0889 | 3'66 |

Since this paper was written it has come to my knowledge that a similar process has been recommended by Messrs. Drown and Shimer, in a communication to the American Institute of Mining Engineers, and published in the *CHEMICAL NEWS*.

The authors quote results which in the main agree with my own, but they do not supply full details of the mode of operating.

The only difference of note between us is that they do not seem to consider the presence of cinder in pig-iron as fully established. From the results of my own experiments I think there can be very little doubt on this point.

REVISION OF THE ATOMIC WEIGHT OF ALUMINUM.*

By J. W. MALLET, F.R.S.,
Professor of Chemistry in the University of Virginia.

(Continued from p. 270.)

First Series of Experiments.

Purification of Ammonium Alum.—Ammonium alum of commerce was dissolved in water, a very little nitric acid added, and the liquid boiled in large glass beakers by passing in a current of steam. When the solution had become cold a little ammonium ferrocyanide was added—a very small quantity sufficed to throw down the traces of iron present—and a little animal charcoal, previously well boiled with strong hydrochloric and nitric acid and thoroughly washed, was stirred in to aid in the subsidence of the minute amount of very finely divided Prussian blue which had been formed. The clear liquid was after about ten day drawn off, and evaporated until the larger part of the alum crystallised out on cooling. The crystals, of which there was obtained more than a kilogramme, were re-dissolved in hot water, and re-crystallised several times (throwing away all the mother-liquors), the last time in a porcelain vessel, and with agitation, so as to obtain a granular crystalline powder, which was washed with cold distilled water.

* From the *Philosophical Transactions* of 1880. Paper read before the Royal Society, April 23, 1880.

Re-dissolving in water the so-far purified alum, now much reduced in quality, it became necessary to secure the exclusion of the metals of the fixed alkalies, lest their alums should exist in isomorphous admixture with the pure ammonium alum required. To this end ammonium hydrate was thrown down from the solution by addition of ammonia, using not quite enough of the reagent for complete precipitation. The precipitate was well washed with abundance of water, this tedious process being much expedited by the use of a syphon-filter delivering the liquid drawn off into a large flask connected with a powerful aspirator. The bulk of the precipitate was twice re-dissolved in pure hydrochloric acid (each time avoiding complete solution), thrown down again by ammonia, and again washed.

This hydrate was now dissolved in just the necessary amount of dilute and very carefully purified sulphuric acid, and just the proper amount added of ammonium sulphate prepared from the same sulphuric acid neutralised with ammonia. The quantities were determined by bringing the two solutions to known bulks, ascertaining by experiment on a sample of each how much of the respective salts was present, and measuring off the required volumes to be mixed. After concentrating the mixed solution by evaporation it was allowed to crystallise by cooling, and the crystallisation was repeated thrice, each time washing with a little cold water. On the last crystallisation pains were taken to regulate the rate of cooling so that as far as possible uniformly small crystalline grains were formed of about a millimetre in diameter, thus avoiding the liability of large crystals to contain cavities, in which mother-liquor might be retained, and on the other hand securing the possibility of seeing with a lens, better than could have been done if the alum were in a still finer crystalline powder, that all the crystals as afterwards used were clear and transparent, and showed no signs of efflorescence.

It should be added that all the aqueous ammonia used as above for the precipitation of aluminum hydrate, and for its re-conversion into alum, was recently and carefully prepared from ammonium chloride purified from alcoholic amines by boiling with nitric acid as recommended by Stas,* that the last crystallisations were effected from water which had been, in pursuance of the practice of the same chemist, distilled from potassium permanganate and hydrate, and that for these last crystallisations a large platinum dish was used, and care was taken that the solution was not allowed to boil, nor even to remain for any length of time near the boiling-point, since I ascertained that ammonium alum, like simple ammonium sulphate, gradually gives off small quantities of ammonia on continued boiling of a strong solution. The very last crystallisation was carried out with only a sufficient quantity of the alum for a couple of the final experiments.

The salt thus purified was found to be free from any

* Quoted in *Presenius's Zeitschrift für Analyt. Chemie*, 6ter Jahrg., 4ter Heft., S. 473.

ascertainable content of foreign substances. It gave no trace of colouration in its solution when tested by a ferrocyanide, tannic acid, &c., and by sulphuretted hydrogen and ammonium sulphide; and spectroscopic examination showed that the fixed alkaline metals and calcium were absent. Silver nitrate gave no indication of chlorine.

Ignition of Ammonium Alum.—Difficulties Connected with this Method.—I proposed to ignite a weighed quantity of this alum, whose distinct crystallisation gives it the advantage as to definiteness in the amount of water over the simple sulphate used by Berzelius, and to determine the weight of the aluminum oxide left behind, but careful examination of this process showed that two difficulties were to be feared.

In the first place, having rapidly dried the product of the last crystallisation by gentle pressure between folds of smooth filtering paper* free from loose fibre, portions were weighed off and exposed to the air at about 22° C., with the hope that before long a constant "air-dried" weight would be obtained. It had been previously ascertained that exposure over sulphuric acid led to large loss of water of crystallisation within a short time. It was found, however, that even in the air loss of weight went on for so long a time that it could not possibly be referred to mechanically adherent water only. It is true that this loss fell off very rapidly after the first hour or so, but it was impossible to decide precisely when it began to affect the water of crystallisation. In order to fully exhibit this I quote the following results obtained from a single large specimen kept very long on hand in a place carefully guarded against dust.

| Original weight of alum after one hour's exposure to the air at 22° C. | | | | Grms. |
|--|-------------------|----|----|---------|
| Loss of weight in 1st | twenty-four hours | .. | .. | 35.7456 |
| " | 2nd | " | " | 0.0088 |
| " | 3rd | " | " | 0.0025 |
| " | 4th | " | " | 0.0017 |
| " | 5th | " | " | 0.0015 |
| " | 6th | " | " | 0.0010 |
| " | 7th | " | " | 0.0012 |
| " | 8th | " | " | 0.0009 |
| " | 9th | " | " | 0.0011 |
| " | 10th | " | " | 0.0007 |
| " | 11th | " | " | 0.0005 |

This series of weighings was carried on at longer intervals for six months more; the monthly loss was at first 0.0087 grm., gradually fell off, became as small as 0.0006 grm. in one month of cold weather when the temperature of the room was unusually low, and again rose, with warmer weather, to 0.0012 grm. for the sixth and last month for which the weighings were continued. It was further found that, on placing some of the small crystals of the alum in a glass vessel deep enough to prevent mechanical loss, sensible loss of weight could be produced by the heat developed in simply crushing and pulverising the salt with a thick square-ended glass rod used as a pestle, and weighed along with the glass and its contents. While, therefore, it might be assumed as probable that mechanically adherent water would be got rid of within a time during which but a very minute quantity of water of crystallisation would be lost, a slight doubt is thrown over the exact formula of the salt as analysed, in reference to this component. Some of the ignition experiments were made with specimens which had been dried by longer exposure to the air than others, as will be noted hereafter.

In the second place it appeared that a minute trace of basic sulphate was retained by the alumina left after ignition at even a very high temperature. This could not be extruded by water, but was detectable by fusion with sodium carbonate free from sulphur, taking care to use an alcohol flame only. By moistening the alumina with a strong solution of pure ammonium carbonate, re-igniting,

and repeating this treatment a second time, it seemed to be possible to remove this source of error, as out of several specimens thus treated only one afforded a barely detectable trace of sulphate.

Details of Method Adopted.—The actual experiments on the ignition of the alum were carried out as follows. To render uniform the amount of atmospheric condensation on the surface of the vessel weighed, a very light glass bottle was specially made, with a delicately blown stopper, the latter carefully ground in and fitting quite air-tight; the bottle, of a size to contain the platinum crucible in which the ignition was to be effected. The crucible was heated to bright redness, and while still quite hot was placed in a desiccator at some distance above a surface of recently distilled sulphuric acid. When cooled down to the temperature of the balance-room the crucible was as quickly as possible transferred to the weighing bottle, which was at once closed, and the combined weight of bottle and crucible was taken. The stopper was then removed for an instant, the cover of the crucible raised, and the quantity of alum desired, which had been roughly weighed off in a tube, having been poured in, occupying in no instance more than one-third depth of the vessel, cover and stopper were replaced, and a second weighing gave, by the gain upon the first, the exact amount of alum used. Attached to the inner side of this crucible cover was a piece of rather stout platinum wire, which, when the cover was in place, ran down into the crucible in the line of its axis of figure, carrying two little diaphragms of platinum foil perforated with small holes (see fig. 1); such a diaphragm



FIG. 1

having been suggested and used by Dumas* in his researches on atomic weights as the means of preventing any loss of solid particles which might otherwise be carried off mechanically from the substance ignited. To avoid inconvenience from the fusion of the alum in its water of crystallisation, and the swelling up of the salt to a bulky, porous mass, the heating was conducted very gradually. The platinum crucible was kept for an hour at 90° C., then for an hour at 100°, for an hour at 110°, another hour at 120°, a like time at 140°, and was then gradually brought to ignition over an argand alcohol lamp. It was then placed inside a larger platinum crucible, resting on a flat bit of unglazed porcelain at the bottom of the latter, and exposed to a gradually increased, and at last bright yellow heat in a gas furnace of Fletcher's construction. This temperature was maintained for a full hour. On cooling down, the smaller crucible was taken out, the cover cautiously raised, and enough of a strong solution of ammonium carbonate introduced to moisten the alumina. Drying gently in a steam-bath, the crucible was re-ignited over an alcohol blast lamp, producing a strong red heat, and the addition of ammonium carbonate, drying, and ignition once repeated. As soon now as the crucible had ceased to be visibly red-hot it was placed in the desiccator as at first, allowed to cool down to the temperature of the balance-room, quickly transferred to the weighing bottle, the stopper of which was inserted, and the final weighing was made while the alumina in the crucible was thus protected from absorption of moisture from the air. These experiments were carried out during a period of remarkably

* This had been previously purified by ample washing with acid and water, and well dried.

* Annales de Chimie et de Physique, loc. cit.

steady weather, with very little variation of atmospheric temperature, pressure, or moisture in the balance-room during the whole series.

Direct Results of First Series of Experiments.—The results were as follows:

A.—Alum dried by exposure to air for 2 hours at 21°—25°C.

| (NH ₄) ₂ Al ₂ (SO ₄) ₃ ·24H ₂ O. | Al ₂ O ₃ . |
|--|----------------------------------|
| I.—8.2144 grms. left | 0.9258 grm. |
| II.—14.0378 " " | 1.5835 grms. |
| III.—5.0261 " " | 0.6337 grm. |
| IV.—11.2227 " " | 1.2657 grms. |
| V.—10.8435 " " | 1.2210 " |

B.—Alum dried by exposure to air for 24 hours at 19° to 26° C.

| | |
|------------------------|--------------|
| VI.—12.1023 grms. left | 1.3660 grms. |
| VII.—10.4544 " " | 1.1796 " |
| VIII.—6.7962 " " | 0.6770 grm. |
| IX.—8.5601 " " | 0.9654 " |
| X.—4.8992 " " | 0.5528 " |

(To be continued.)

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING MAY 31ST, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
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and C. MEYMOTT TIDY, M.B., F.G.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington; and late Deputy Medical Officer of Health for the City of London.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

June 5th, 1882.

SIR,—In the following tables you will find recorded the results of our analyses of the 180 samples of water collected by us during the month of May, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 180 samples, one was recorded as "slightly turbid" and two as "very slightly turbid." The remaining 177 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from May 1st to May 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, the whole, excepting one which was "slightly turbid," were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, the whole, excepting one which was re-

corded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole, excepting one which was recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, the whole were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

During the past month the condition of the waters, as regards colour, has been unexceptionable. With respect to their freedom from turbidity, never, with one exception, since we commenced our examinations a year and a-half ago, have the waters approximated so nearly to a state of perfect filtration as they have during the past month. They have, moreover, presented their usual excellent condition of aeration.

The proportion of organic matter, as deduced alike from the results of the Oxygen and the Combustion processes, was, especially during the earlier part of the month, in excess of the very low proportions to which we directed attention in our preceding Reports. The amount of excess, however, was not important or calculated to affect the character of the water in respect to wholesomeness and suitability for domestic purposes.

We have the honour to remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

NUMERICAL RESULTS FOR THE MEAN RATIO OF OXYGEN TO THE SUM OF OXYGEN AND NITROGEN IN ATMOSPHERIC AIR.*

By EDWARD W. MORLEY, of Hudson, Ohio.

(ABSTRACT.)

SINCE the proportion of oxygen to nitrogen in the air varies almost as incessantly as its temperature or pressure, the mean value can be accurately ascertained only by regular and continuous observation. The true value cannot be safely inferred from observations at irregular intervals.

A series of daily analyses in duplicate, continued for six months, undertaken for a very different purpose, may therefore be of some interest as contributing to the knowledge of this constant.

The result is affected with errors depending on the following causes, the probable magnitude of which is well known.

1. The most serious uncertainty depends on the uncertainty of the calibration of the eudiometer. The probable error of a single determination at any given point on the scale is three milligrammes of water. At each point four determinations were made, so that it is as likely as not that the volume at any given point is known within a milligramme and a half of water. The probable error of the mean result, as far as this error depends on errors of calibration, is 0.0014 per centum.

2. The second source of uncertainty depends on the fact that the composition of the air is variable. Owing to this variation, the result of the number of samples analysed is as likely as not to differ from the result from an unlimited number of samples by 0.0009 per centum.

3. The third source of uncertainty depends on the accidental errors of analysis. Owing to these errors, the

* *Proceedings of the American Association for the Advancement of Science*, vol. xxix., Boston Meeting.

mean result obtained from two analyses of each sample is as likely as not to differ from what would have been obtained by an unlimited number of duplicate analyses of each sample by 0.0002 per centum.

This result is also affected with one source of constant error which has not yet been taken into account. This error is due to the fact that the eudiometer tube, after the explosion, contains a larger volume of water than at the previous measurement. I do not see clearly how to determine the magnitude of this error.

It is at present hoped that other sources of error produce only results which may safely be neglected in comparison with these.

The mean composition of the air, and the magnitude of the errors attending the determination, may then be stated as follows:—

| | |
|---|----------------|
| Ratio of oxygen to sum of oxygen and nitro- | |
| gen, | 20.949 per ct. |
| Probable error from imperfect calibration, .. | 0.0014 .. |
| Probable error from variation in ratio, .. | 0.0009 .. |
| Probable error from accidental errors, .. | 0.0002 .. |
| Total probable error, | 0.0016 .. |

SOME CONCLUSIONS AS TO THE CAUSE OF THE FREQUENT FLUCTUATIONS IN THE RATIO OF OXYGEN TO NITROGEN IN THE AIR AT DIFFERENT TIMES.*

By EDWARD W. MORLEY, of Hudson, Ohio.

(ABSTRACT.)

To study the subject above indicated, I have made duplicate analyses of air collected at Hudson, Ohio, on every day from January 1st to June 30th, 1880. The results have been graphically compared with the daily observations on temperature and pressure of the atmosphere made by the Signal Service at Cleveland, Ohio, from which Hudson is not far distant. Many of the variations in the amount of oxygen observed are closely connected with variations in the temperature and pressure. For the prediction or explanation of these, local observations of temperature and pressure might be sufficient.

I have also been favoured, through the courtesy of General Myer, with the thrice-daily maps of the state of the weather for the period mentioned. From a comparison between these maps and the results of my analyses, I derive some interesting conclusions, serving to confirm the notion that most of the variations in the amount of oxygen are caused by the vertical descent of air from above. I find this notion strikingly confirmed in some cases where it was some time since evident to me that Loomis's suggestion that the cold was caused by the descent could not be accepted as holding good. I find evidence that some depressions of temperature are caused by such descent, and at such times the amount of oxygen falls promptly at the beginning of the cold. But with the times of depression of temperature remarkable for their suddenness and severity, a vertical descent of cold air seems to be the effect and not the cause. The descent follows the cold by a day or two or more, and at the time when the Signal Service maps lead me to suppose the descent has begun, and not till then, the fall in oxygen occurs.

The variations found this year have not been as great as those published by me last year, nor as great as those found by Jolly. I have therefore carefully re-examined those made before this year, and am confirmed in my confidence that they are affected with no unsuspected error.

ON THE DETERMINATION OF PHOSPHORUS IN IRON AND STEEL.

By E. AGTHE.

THOUGH very numerous methods have been proposed for this determination the only one generally used is the old process with molybdic acid, followed by precipitation with magnesium mixture. The author finds that the precipitation with molybdic acid is the delicate point of the process, and that the following precautions conduce to the greatest accuracy. The authors who have occupied themselves with the question give conflicting instructions as to the time necessary for the complete precipitation of the phospho-molybdate. Classen specifies of four to six hours; Fresenius and Ledebur (*Guide pour l'Analyse Metallurgique*, 1880), indicates twelve hours. The author has found that on operating as laid down below four hours are amply sufficient, and that a more prolonged contact is often the cause of defective results. If the analyst is pressed for time he may even filter after one hour.

Five grammes of the sample are dissolved, 50 c.c. of the molybdic liquid are added, the mixture is stirred frequently and filtered after four hours.

In these conditions the determination is exact when the proportion of phosphorus does not exceed 11 to 15 (0.11 to 0.15) per cent. Beyond this range the result becomes uncertain. For a proportion of 43 (0.43) per cent., 50 c.c. of the molybdic solution are required, as this reagent must always be in excess. In place of 50 c.c. 75 or 100 c.c. of the molybdic solution are employed which is still suitable for proportions of phosphorus of 7 and even 8 (0.7 and 0.8) per cent. If the percentage is still higher, only 2 grms. or 1 grm. of the sample should be dissolved. The nitric acid should not be too concentrated or employed in excess, as it hinders complete precipitation. As far as possible the carbon should be burnt off, as the presence of this element renders the result too low.

If in the analysis of steel, white pig-iron or manganese iron—in short iron low in silica,—this body is not separated, the result is too high. It is necessary therefore to filter before adding the molybdic acid even in cases where no distinct precipitate of silica can be seen.

Before filtration the solution should be let take the ordinary temperature of 15° to 20°, otherwise the filtrate will become turbid and deposit a slight precipitate. The author operates as follows:—He dissolves 5, 2, or 1 grm. of the sample, according to its supposed richness, in 50 c.c. of nitric acid; he then evaporates to dryness and heats rather strongly, and to eliminate the last traces of nitric acid he evaporates a second time with hydrochloric acid. The residue treated with concentrated hydrochloric acid is taken up in water, and the silica which remains insoluble is separated by filtration. The liquid is evaporated again over a naked flame in a porcelain capsule as long as the ferric chloride which is deposited on the sides of the vessel re-dissolves on inclining the capsule, and the process is then continued on the water-bath to incipient solidification. This operation requires to be watched, for if there remains too much hydrochloric acid the results are too low; if, on the contrary, too much acid is driven off and hard crusts are formed, we do not obtain a clear solution with nitric acid.

After cooling, we add 35 c.c. of ammonia (0.96) and mix with the stirrer, so as to obtain a homogeneous paste, and add 75 c.c. nitric acid (1.12 to 1.20) and the whole is set on the water-bath. When the solution is complete the liquid is transferred into a precipitating glass and from 50 to 120 c.c. of the molybdic solution are added and the whole is kept at a temperature of 50° to 80°, stirring frequently. After four hours it is let cool, filtered, and washed with dilute molybdic liquid. The author recommends the following proportions for the preparation of the molybdic solution:—115 grms. of molybdic acid are dissolved in 450 grms. ammonia (0.96) and made up with

* Proceedings of the American Association for the Advancement of Science, vol. xxix., Boston Meeting.

water to 1 litre. This solution is then poured into 1 litre nitric acid at sp. gr. 1.20, and the mixture is let stand for a day and filtered.

When the phospho-molybdic precipitate has been sufficiently washed it is dissolved in the smallest possible quantity of ammonia; the ammoniacal solution is neutralised with hydrochloric acid up to the point where the precipitate produced by this reagent is re-dissolved very slowly, and when cold it is mixed with 15 to 25 c.c. of magnesia-mixture, stirred well and filtered after standing for six hours. The precipitate is washed with ammoniacal water, dried, calcined, and weighed.

The author prepares his magnesia-mixture as follows:—

| | | | |
|------------------------|----|----|-------|
| Magnesium chloride | .. | .. | 101.5 |
| Ammonium chloride | .. | .. | 300 |
| Ammonia (sp. gr. 0.96) | .. | .. | 400 |
| Water | .. | .. | 1000 |

It is well to ascertain that the mother-liquors from the ammonium phospho-molybdate when mixed with ammonia slightly heated does not give a further precipitate; in the contrary case the analysis would be inaccurate. It may, however, be completed by neutralising as far as possible with ammonia, adding molybdic liquid, and adding the second precipitate to the former.—*Moniteur Scientifique.*

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, June 24th, 1882.

Prof. CLIFTON, President, in the Chair.

New members—Professor Bartholemew Price, Principal Viriamu Jones.

Prof. G. CAREY FOSTER moved a vote of thanks to Prof. Clifton for the excellent reception accorded to the Physical Society at Oxford on the preceding Saturday, and drew attention to the high efficiency of the Clarendon Laboratory and the admirable provision made for the teaching of physics at Oxford.

Prof. W. G. ADAMS seconded the motion, and endorsed Prof. Foster's views of the position of physical science on the Isis.

Prof. CLIFTON, in response to the vote, stated that the University of Oxford had liberally supported him in organising the Clarendon Laboratory, giving him all the funds he required, and showing a laudable desire to put physical teaching on the best possible footing in Oxford.

Professor C. A. BYRNESS, of Christiania, was then introduced to the meeting, and, assisted by his son, M. Vilhelm Bjerknes, delivered a lecture on "*Hydrodynamic Analogies to the Phenomena of Electricity and Magnetism*," which was illustrated by experiments and projections on the screen. Prof. Bjerknes has been engaged in tracing these analogies for the last twenty-five years: at first mathematically, but latterly by experiments in verification of the deductions from his formulæ. These experiments were shown in the Paris Electrical Exhibition last year, and have been published repeatedly in this country. Prof. Bjerknes has, however, advanced beyond the results there shown. These were chiefly confined to illustrating the static attraction and repulsions of electricity and magnetism; but he has now taken up the subject of electrodynamic attractions and repulsions. The former effects are shown by brass balls oscillating, or by small tambours pulsating, near each other in water. These motions are communicated to the balls and drums by pulses of air, transmitted from an ingenious air-pump or bellows along india-rubber tubes. A pulsating drum corresponds to a magnetic pole: an

oscillating body to a magnet. When two tambours are vibrating near each other in like phase they attract; when in unlike phase, they repel each other. The same holds true of the oscillating balls. The motion lines round these bodies correspond to the lines of force round magnets, as was demonstrated by a hollow ball oscillating on a stem, and tracing its movements in ink on a glass plate. All the phenomena of magnetic forces were illustrated in this way by Prof. Bjerknes, including diamagnetism, which was shown by means of pith cylinders lighter than the water or medium of oscillation. A pulsating drum or oscillating ball repelled the cylinder of pith, whereas it attracted a cylinder of wax, which is heavier than the water. The more novel part of the experiments consisted in representing the attraction between two electric currents flowing in the same direction, by means of two cylinders, about 5 inches long and 1 inch in diameter, oscillating round their longitudinal axes at close quarters in the water. The cylinders were oscillated by means of a pulsating tambour, which communicated its motion to them by a toothed gearing on their ends. Attraction resulted when the oscillations of the cylinders were in the same phase, and repulsion when they were in opposite phase. This is an inversion of what might have been expected to take place after the theory of Ampère. A square of four oscillating cylinders was also formed, and a fifth cylinder oscillated inside it, the attraction or repulsion exerted on the latter being observed. A hydrodynamic galvanometer was made by placing an oscillating ball (which corresponds to a magnet) beside an oscillating cylinder, the result being a deflection of the ball according to the direction of the oscillation of the cylinder. The experiments were witnessed by a full meeting, which accorded a hearty vote of thanks to Prof. Bjerknes.

A paper by Dr. C. R. ALDER WRIGHT, F.R.S., was taken as read. It was on "*The Determination of Chemical Affinity in Terms of Electromotive Force*" (Part VI.), and on the relations between the E.M.F. in cells constructed like Daniell's cell, but containing different metals, and the chemical affinities involved in their actions. The cells employed were constructed of cadmium and copper and their sulphates, zinc and cadmium and their sulphates, zinc and silver and their sulphates, cadmium and silver and their sulphates, copper and silver and their sulphates. In all cases the sulphate solutions were of equal molecular strengths. The general result is that the effect of a given alteration in the character of the plates opposed to cadmium or silver was found to be practically identical with that of the same alteration in the case of a Daniell cell. Volta's law of the summation of electromotive forces sensibly holds true in the cases examined. These cells also behave like a Daniell under variations of current density.

The Society meets again in November.

NOTICES OF BOOKS.

Coal. Spontaneous Combustion and Explosives occurring in Coal Cargoes: their Treatment and Prevention. Also the Prevention of Fire or Explosions in Ships from Cargoes or Stores containing Substances of a Volatile and Inflammable Nature. By THOMAS ROWAN. London and New York: E. and F. N. Spon.

The public has long been aware of the dangers which arise in coal mining from the emission of gases, highly combustible, and when mixed with atmospheric oxygen, explosive. But it has only of late become generally known that the danger does not cease when the coal is raised to the surface, but continues to exist when it is taken on board ship, either as an article of commerce or for working the engines of steamers. Coal is in fact rightly described by the author as a "most dangerous and treacherous

cargo." Not a few attempts have been made to combat the evil, and in 1875 a Royal Commission was duly appointed to investigate the subject. But so little practical benefit has resulted from the investigations undertaken and the recommendations issued that at Liverpool the premiums for underwriting coal cargoes have lately risen 5s. to 10s. per cent.

Spontaneous combustion, commonly so-called, in coal may arise from two causes. On the one hand is the oxidation of the iron sulphide, iron-pyrites, known to coal miners as "brasses" or brass lumps, which are never entirely absent in coal. This sulphide varies much in its physical conditions and in its consequent stability. Some varieties, if they come in contact with the air, rapidly absorb oxygen, and evolve considerable heat, as is perhaps most strikingly exemplified in the Campsie mines, near Lennox Town.

But the oxidation of sulphur present as iron sulphide is neither the only, nor, in the opinion of some authorities, the most effectual, agency in the ignition of masses of coal. The coal itself can absorb oxygen just as is done by shoddy, cotton-waste, weighted silks, &c., and can thus become heated to the ignition point. This view, put forward by Dr. Percy as far back as 1864, has been since experimentally demonstrated by Prof. Richters, who shows that the liability of coal to self-inflammability bears no relation whatever to the percentage of sulphur actually present. We must here, however, submit that a not unimportant element has been left out of consideration in the tabulated results of Prof. Richters, and that is the relative stability of the iron sulphide in different kinds of coal. There are kinds so dense that they are carefully rejected by the copperas manufacturers, who find that they may be exposed to air and moisture for a year or upwards without becoming appreciably oxidised, whilst others quickly swell up, crumble, and liberate heat. It is hence, we submit, evident that from the total percentage of the sulphur in a coal, taken without regard to its condition, no conclusion can be drawn as to its tendency to bring about ignition. The author doubts, indeed, whether the conditions in the experiments of Richters are the same as those which exist in a cargo of coal or in the hunkers of a steamer. He contends that the facts disclosed in the Report of the Royal Commission show that "in the majority of cases, chemical action has been first set up by the oxidation of the iron pyrites in the coal." Thus the liability to spontaneous combustion increases *pari passu* with the tonnage of the cargoes, which is precisely what we should expect if the ignition is determined by the oxidation of pyrites. Thus in cargoes below 500 tons the casualties were under $\frac{1}{2}$ per cent; in cargoes from 500 to 1000 tons the proportion was 1 per cent; between 1000 and 1500, it reached 31 per cent, whilst with cargoes of over 2000 tons the proportion of casualties reached 9 per cent. This increase is the most striking in the case of long voyages. Out of five ships with cargoes of over 2000 tons sent in 1874 to San Francisco two suffered.

It further appears that in the majority of cases dealt with in the Report the coal had been shipped in a damp state. It was stated before the Commission that one and the same kind of coal, taken from the same working, if protected from the rain remained cool, whilst another portion of the same lot, which had been left uncovered and become wet, set up spontaneous combustion. Now moisture, whilst favouring the oxidation of pyrites, is, in the author's opinion, likely to prevent the oxidation of the carbon by filling its pores. Hence, he argues that in the majority of cases the ignition has been primarily determined by the oxidation of the pyrites, the heat thus liberated inducing, probably, carbonaceous oxidation also. When once a certain temperature has been reached, gaseous and volatile products of the destructive distillation of coal naturally appear, and may sometimes cause the cargo to burst into flame. But such products can of course never be the original cause of the rise of the temperature.

Mr. Rowan next criticises a work written in 1878 by Mr. J. W. Thomas, F.C.S., entitled "A Treatise on Coal, Mine-gases, and Ventilation." Some of the passages here quoted are very remarkable, e.g., the assertion that pyritiferous coals are rarely shipped.

One of the chief conclusions of the Royal Commissioners—which the author describes as of a very negative character—is that the breakage of coal in its transport from the pit to the ship's hold, the shipment of pyritic coal in a wet condition, and especially ventilation through the body of coal cargoes—which Mr. Thomas recommends—conduce to spontaneous combustion. A system of surface ventilation for the escape of explosive gases in all weathers is proposed.

Mr. Rowan's own proposals are, first a system of "abstractors" scattered through the coal-holds at different levels, and capable of being brought into action as occasion arises, and as determined by means of thermometers placed in the indicators themselves. When coal is destined for a long voyage, or when it is known to be of a dangerous nature, he suggests that it should be brought from the pit in shallow iron waggons with perforated sides and bottoms. These waggons prior to shipment should be run into stove-houses and submitted to a temperature of 150° F. for a length of time varying from one to eight days, and should then be allowed to cool, protected from the weather.

In this manner carbonaceous oxidation would be anticipated, so that any further danger from this source on board ship would be excluded. Any fire-damp existing in the pores of the coal would be driven off, and the removal of moisture would render pyritic oxidation less likely. As regards the efficacy of this plan we feel little doubt, but we fear that the erection and management of these stove-houses would prove in practice too costly. It would require a large building to receive 2000 tons of coal in shallow waggons.

An important fact is here mentioned, that no cases of spontaneous combustion have occurred with cargoes of patent fuels.

Space does not allow us to discuss the author's remarks on explosives arising from such bodies as "xerotine siccative." Mr. Rowan's work must be pronounced a timely publication, and deserves the attention of all persons directly or indirectly connected with the exportation of coal.

Proceedings of the American Pharmaceutical Association at the Twenty-ninth Annual Meeting, held in Kansas City, August, 1881. Philadelphia: Sherman and Co.

THE first portion of the "Report on the Progress of Pharmacy" contains a notice of several recent kinds of apparatus, such as the balances of Westphal, of Bunge, and Ruprecht, Pellet's burette, Gantler's extraction apparatus, Weigelt's displacement apparatus, Molin's rapid filter, Terquem's gas-burner, &c. In an extract on soaps it is stated that the so-called rock potash or ball potash sold in the United States without exception not only is not potash, but is composed exclusively of soda, and is consequently useless for the manufacture of soft soaps.

It appears, according to Limousin, that in preparing oxygen from chlorate of potash without the presence of manganese peroxide explosions are possible. In the latter part of the process potassium perchlorate is formed, and particles of this, carried over in to the vulcanised tubes (if such are used), may become ignited and produce hydrocarbons, which form an explosive mixture with the oxygen.

According to Mr. R. F. Fairthorne, muddy water may be purified by adding to it "phosphate of lime"—whether soluble or insoluble does not appear—in the proportion of 1 oz. to 1 quart, and allowing it to settle. In a few days (!) it may be filtered. This process seems too expensive and too tedious for practical purposes.

We regret to see the increasing tendency, e.g., in Arkansas, to lay restrictions upon the sale of important chemicals under the pretext that they are poisonous. So long as explosives are freely sold to all comers, to enact regulations concerning the sale of poisons is indeed to "strain at a gnat and swallow a camel." To add to the farcical character of these enactments, quack medicines are in some cases especially excepted from their operation.

We are glad to perceive that the "Food and Drug Adulteration Act" of Michigan, prohibits the addition of glucose or starch sugar to articles of human food, and that of oleomargarine, suine, &c., to butter and cheese, without stating distinctly on the label the proportion of the addition. A similar enactment in England would open the eyes of the public to the true nature of the mixture mendaciously sold as "coffee as in France." Prof. P. W. Bedford states that all the commercial varieties of sodium phosphate examined contained sodium sulphate ranging from 19.5 to 57.5 per cent.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xx., Part 4.

Trustworthiness of Experiments on Heating.—A. Wagner.—A continuation of the author's researches on the trustworthiness of analyses of the gaseous products of combustion, being a reply to Dr. Bunte (*Zeitschrift Anal. Chem.*, xx., 163).

Behaviour of Manganese Ore and Chloride of Lime on Ignition with Chromic Oxide and Sodium Carbonate in the Absence of Air.—A. Wagner.—Already noticed.

Sulphur in Zinc Powder.—A. Wagner.—Two samples of zinc powder were found to contain respectively 0.12 and 0.01 per cent of sulphur. A sample of rod zinc sold as chemically pure contained 0.004 per cent of sulphur.

Bismuth Oxide as a means of rendering Silicates Soluble.—W. Hempel.—Already noticed.

Metallic Copper as an Absorbent for Oxygen Gas.—W. Hempel.—The author has for some time been engaged with experiments on the use of metals at common temperatures as absorbents for oxygen in presence of ammoniacal vapours. This absorption proceeds with rapidity as long as bright metallic surfaces are exposed to a gaseous mixture containing oxygen, but ceases or becomes very slow as soon as appreciable quantities of oxide are formed. He has therefore examined if it is possible to effect complete absorption by using ammonium carbonate as a solvent for the oxides formed. Experiments proved that oxygen was quickly and completely absorbed in contact with copper and a solution of commercial ammonium carbonate, but that appreciable quantities of carbonic acid were evolved. Complete absorption of oxygen without the development of any gas was effected if it was exposed to metallic copper and a solution consisting of equal parts of a saturated solution of commercial ammonium sesquicarbonate, and a dilute solution of ammonia at 0.93. Such a liquid has a tension which may in most cases be disregarded, and if the apparatus contains sufficient quantities of metallic copper it is able to take up 24 vols. of oxygen.

An Apparatus for Fractional Distillation.—W. Hempel.—This paper cannot be reproduced without the accompanying illustration.

Analysis of Crude Zinc.—O. Günther.—This memoir will be inserted at length.

A New Method for the Volumetric Determination of Molybdenum.—F. Mauri and L. Daneli.—The determination of molybdic acid succeeds very well if potassium iodide is used proportionally to the molybdic acid which may be present, and in such a proportion that rather more than 2 mols. of potassium iodide are used to 1 mol. of molybdic acid. A moderate excess does not interfere with the final result. The reaction takes place perfectly at common temperatures when the molybdate, dissolved in hydrochloric acid, is digested for some hours with the potassium iodide.

Determination of Nicotine.—R. Kissling.—The author calls attention to the inaccuracies in Skalkweit's recent memoir on the quantitative determination of nicotine in tobacco (*Repertorium der Analyt. Chem.*, vol. i., No. 11, p. 165).

A Simplification of Glinski's Platinum Wire Net in Fractional Distillation.—A. Belohoubek.—This paper requires the accompanying illustration.

A Convenient Process for Obtaining Metallic Zinc in Forms suited for Analytical Uses.—C. Mann.—The author melts the zinc at a low temperature over the gas flame in a porcelain crucible or in a muffle furnace in earthen crucibles, in each of which some borax ought to be previously melted so as to glaze the inner surface. The melted metal is poured in small quantities upon a polished flag-stone inclined at an angle of 25° to 30°. In this manner the metal is obtained in bands half a litre in length and 0.2 to 0.5 m.m. in breadth. They are perfectly free from oxide, very brittle, and crystalline in texture.

Process for Manipulating with Sulphuretted Hydrogen.—G. S. de Capanema.—This memoir is unintelligible without the accompanying illustration.

Trustworthiness of Experiments on Heating.—H. Bunte.—A reply to A. Wagner's memoir contained in the present issue.

Corrected Performance and the Sensitiveness of the Method of Fresenius and Babo for the Detection of Arsenic.—W. Fresenius.—This paper will be inserted at length.

A Micro-prismatic Method for Distinguishing Solids.—O. Maschke.—The author makes use of the circumstance that particles of a transparent substance, if surrounded by a liquid which possesses a higher refraction index than the solid in question, display under the microscope very characteristic colours, the intensity of which increases with the difference of the refraction-indices. If particles of a substance, however minute, are by degrees enveloped in liquids of different refraction-indices, it is easy to find a liquid which produces the faintest intimation of these colours, and has consequently almost exactly the same refraction-index as the body itself. If this is then determined for the liquid it is known for the body in question. The author uses as liquids, water, amylalcohol, glycerin, oil of almonds, and oil of cassia. All bodies are of course excluded from this method which are opaque, or possess a refraction-index higher than oil of cassia (1.606), or are attacked by the liquids.

Nitrite Solution of Potassium Iodide and Starch Mixture.—A. Vogel.—The author has examined this mixture as regards its behaviour with acid liquids. He used a very dilute potassium iodide starch paste, to which he added so much potassium nitrite that the liquid was coloured deeply blue by a few drops of acetic acid. It was coloured a deep blue by dropping in moderately dilute solutions of most inorganic and organic acids and acid salts, whilst weak and sparingly soluble acids, such as the carbonic, boric, arsenious, uric, carbonic, tannic, had no action.

The Behaviour of Ferrous Sulphate on Keeping.—E. Johanson.—Ferrous sulphate becomes oxidised the more readily the more completely the external air is excluded. To explain this phenomenon he suggests that

the ferrous sulphate has an ozonising action upon the oxygen of the inclosed air, which then reacts the more strongly upon the ferrous sulphate the less it is diluted by the external air.

Preservation of Standard Solutions of Stannous Chloride.—Sorge recommends that these liquids should be kept in a bottle tubulated at the bottom, so that the solution is drawn off below, whilst coal-gas is allowed to enter above to fill up the vacancy.

A Coloured Reaction of Atropine and Daturine.—D. Vitali.—If a specimen of either of these alkaloids or of their salts is covered with a little fuming nitric acid, let dry up on the water-bath, and when cold moistened with a drop of potassa dissolved in absolute alcohol, a violet colour is instantly produced, and soon passes into a fine red. Only the violet colour is characteristic, as strychnine also gives a beautiful red colour if similarly treated. According to the author, 0.00001 grm. of atropine sulphate can thus be detected. None of the other important alkaloids give a similar reaction.

Action of Copper Hydroxide upon Certain Kinds of Sugar.—J. Habermann and M. Hönig.—The pure hydroxide, if boiled with aqueous solutions of levulose, dextrose, inverted sugar, and cane-sugar, is reduced to cuprous oxide. With levulose, dextrose, and inverted sugar the reaction begins at once with ebullition, and goes on rapidly with levulose and inverted sugar, but more slowly with dextrose. With cane-sugar the change sets in only after several hours boiling, i.e., probably after the cane-sugar has been inverted. The following oxidation products were observed in all the above-mentioned sugars: Carbonic, formic, and glycolic acids, and an amorphous residue not yet fully examined. If barium hydroxide is allowed to act along with copper hydroxide the same acids are formed, but the process is more rapid. Copper hydroxide acts upon milk-sugar in the same manner, but the decomposition-products have not been further examined.

Oxidation of Caffeine and Theobromine.—R. Maly and F. Hinteregger.—If caffeine is boiled for six hours with chromic acid mixture it is completely oxidised, yielding 40 per cent of cholestrophan or dimethyl-parabanic acid. Theobromine, if similarly treated, gives the homologue of cholestrophan, mono-methyl-parabanic acid.

Determination of Nicotine.—J. Skalweit.—We may return to this memoir on a future occasion.

Determination of Starch and Dry Matter in Potatoes.—M. Märcker.—The author gives tables showing the relation of the proportions of these constituents to the specific gravity.

Determination of Carbonic Oxide in Air.—J. v. Foder.—The author allows moderately diluted blood to remain in contact with the air in question in a 10- to 12-litre bottle, or he passes 10 to 12 litres of the air through the blood, and then shakes it up in a test-tube with ammonium sulphide. Unmodified blood appears violet by transmitted light, whilst that which has absorbed carbonic oxide is coloured red. For the quantitative determination of the carbonic oxide absorbed by blood the latter is put in a small flask, through the doubly perforated stopper of which are passed two tubes. The one, which reaches to the bottom, serves to introduce air washed by a passage through palladium chloride. The other conducts the air issuing from the flask into two washing-bottles, one of which contains a solution of lead acetate, and the other dilute sulphuric acid. From the washing-bottles the air passes into two U-tubes containing palladium chloride. The flask is then set on a water-bath, and the blood kept for a quarter of an hour to half an hour at 90° to 95°. Meanwhile an exceedingly slow current of air is aspirated through the flask, which is frequently shaken. As soon as the colour of the blood begins to change the carbonic oxide hæmoglobin is split up, the carbonic oxide is set free, and a black precipitate

of palladium appears on the surface of the solution of palladium chloride. This is separated, washed, dissolved in aqua regia, and the solution is treated with a standard solution of potassium iodide (1.486 grm. KI in 1 litre) till a filtered portion no longer gives any turbidity with a drop of the potassium iodide. In this manner its quantity and consequently the quality of the carbonic oxide can be calculated. Each c.c. of the potassium iodide represents 0.1 c.c. carbonic oxide.

Absorption of Carbonic Oxide by means of Blood.—C. H. Wolff.—In order to preserve such blood for spectroscopic observation the author uses a mixture of equal parts of defibrinated blood and of solution of borax, saturated in the cold. If it is desired to detect carbonic oxide in combustion products the air must first be passed through a washing-bottle with slaked lime, to absorb all acid products which destroy the colouring matter of blood.

Determination of Organic Matter in Air.—Ira Remsen.—The air is passed by means of an aspirator through a tube drawn out at one end, 5 to 7 inches long and 3 to 8 inches in diameter, filled with coarse pumice moistened with water. In ten hours 90 to 100 litres of air are passed through the absorption tube, in which the ammonia and the organic matter are retained. The pumice is then covered with 500 c.c. water in a suitable vessel, and the liquid is treated for free and for albumenoid ammonia, according to the process of Wanklyn, Chapman, and Smith.

Detection of Ammonia and other Impurities in the Atmosphere.—A. H. Smee.—The author fills a glass funnel, drawn out to a point and closed at the bottom, with ice. The dew which condenses from the air on the cold sides of the funnel collects in drops, which run down over the closed point into a capsule. The quantity of water condensed in a given time may be measured, and the ammonia determined colorimetrically. By this cold distillation, it is possible to concentrate bodies which are decomposed at higher temperatures, e.g., the odours of flowers. In the condensed dew may be found the microbes or parts of such thrown off from the body in disease.

Examination of Flour for the Ordinary Impurities and Adulterations.—A. E. Vogl.—The author adds to dilute alcohol at 70 per cent, 1-20th of hydrochloric acid. About 2 grms. of the flour in question are shaken up in a test-tube with 10 c.c. of this liquid, and the colour, both of the solution and of the sediment which gradually collects at the bottom, are observed. In some cases a change of colour is observed at once, but in others it only occurs on standing, and is promoted by heat. Pure flour (wheat or rye) remains white, and the liquid is colourless, showing merely a yellowish tint in coarse qualities. Pure barley and oatmeal give a straw-yellow liquid. Corn cockle colours the liquid a full orange; vetches and beans, a fine purple-red.

Detection of Rhinanthine in Bread.—C. Hartwich.—An alcoholic extract of the bread or flour is boiled with some hydrochloric acid. If rhinanthine is present the liquid on cooling takes an intense green colour.

Speed of Evaporation of Pure Water.—A. Müller.—The author has devised for this purpose an exact hydrostatic balance, which he names the xerometer.

Detection of Alcohol in Essential Oils.—E. Barbier.—The author distils off 1-10th and adds to the distillate an excess of dry potassium acetate, which forms with the alcohol a heavy solution, and can be separated by means of a separation funnel from the supernatant ethereal oil; it is then mixed with 4 vols. of water, and again saturated with potassium acetate, by which means a further quantity of essential oil is separated out.

The Detection of Fusel in Alcohol.—A. Jorissen.—The author adds to 10 c.c. of the sample 10 drops of colourless aniline oil and 2 to 3 drops of official hydrochloric acid. If fusel is present a red colour soon appears.

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